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ENVIRONMENTAL STATEMENT
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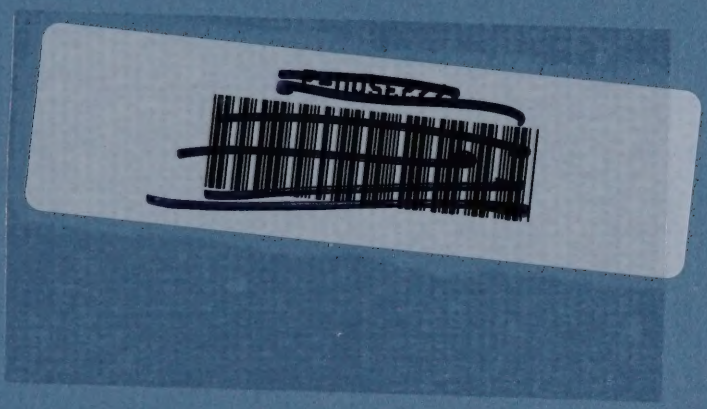

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ERT Document P-3661-B
April 1978

Prepared for
U.S. DEPARTMENT OF THE INTERIOR
Bureau of Land Management
Building 50, Denver Federal Center
Denver, CO 80225

ENVIRONMENTAL RESEARCH & TECHNOLOGY, INC.
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DESCRIPTION OF EXISTING CLIMATE AND METEOROLOGY

The ES region lies within the broad geographic region known as the Great Wyoming-Big Horn Basin. The average mean sea level elevation is about 7,000 feet.

General Climatology

The climate of the ES region is relatively cool and semiarid in the basin areas; cool but subhumid conditions characterize the mountainous regions.

The latitude of the ES region (40°N) positions it within the mid-latitude belt of westerly winds. Large storms and associated precipitation generally occur most frequently in this belt during the winter and early spring. However, because the ES region is located within the central Rocky Mountain plateau, its climate is varied and substantially modified compared with other locales having a similar latitude.

In general, maximum monthly precipitation occurs from April to June at the lower elevations in the ES region, whereas it is more evenly distributed throughout the year in mountainous areas.

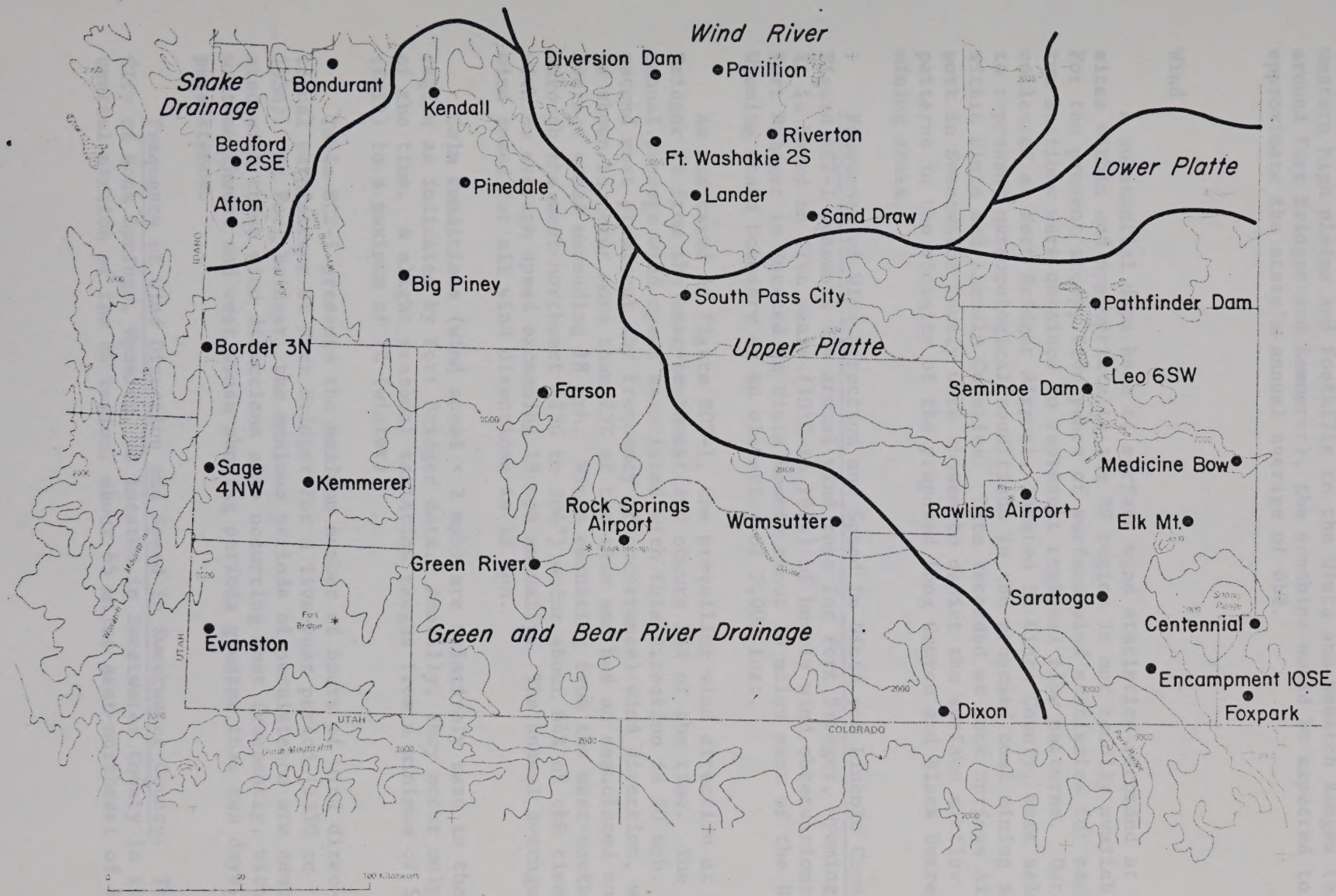
Because of the high elevation of the ES region, monthly mean temperatures remain relatively low. In addition, there is a large diurnal (daily) variation of temperature, which is maximized in the summer.

Specific Climatological Parameters

The following sections summarize the climate of the ES region according to several climatological variables. The State of Wyoming's Climatic Divisions are presented in Map SC2-1 as well as the observation sites used in this regional study. The map also delineates the major topographic barriers that influence the climate of this region.

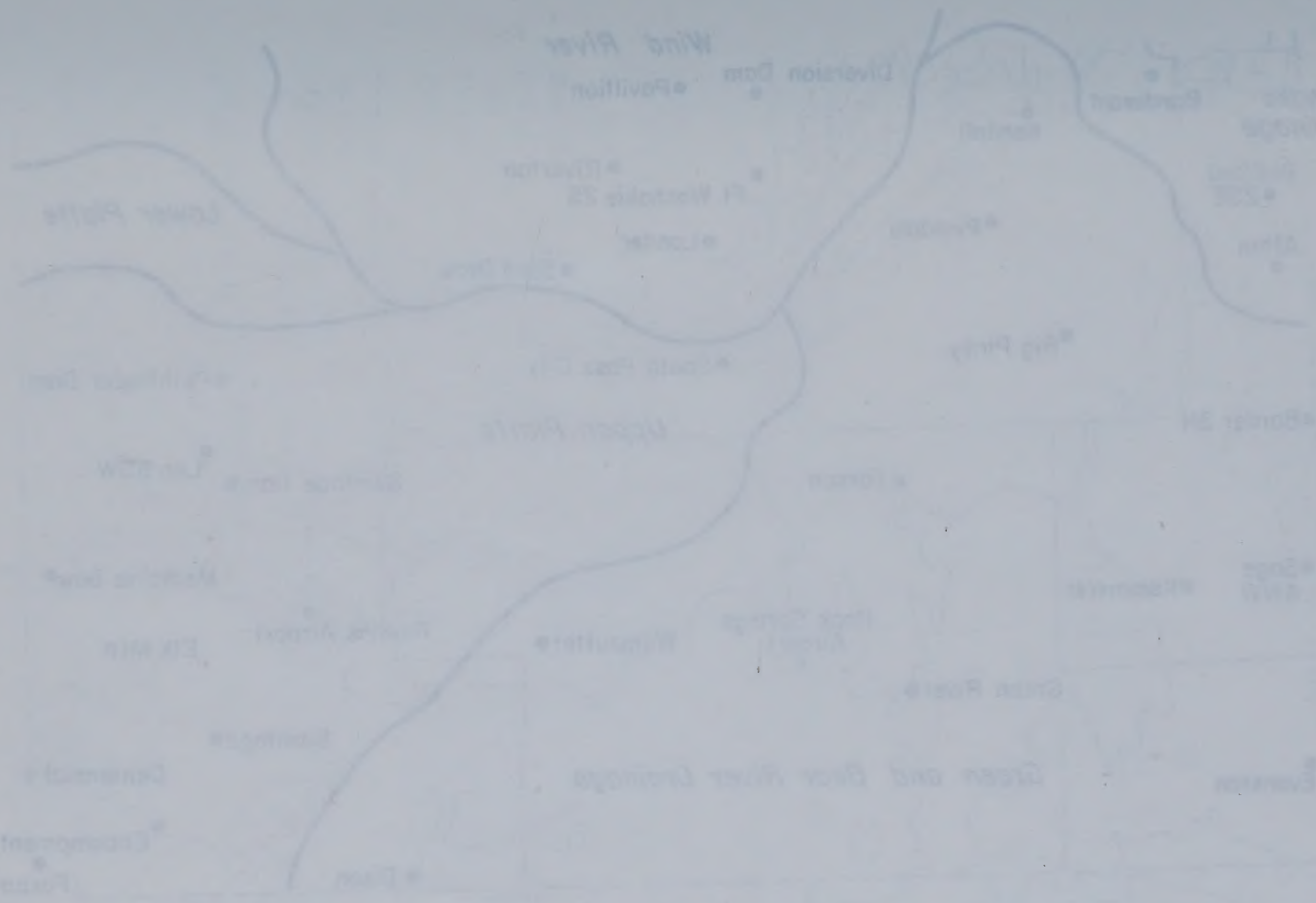
Sunshine

This data is recorded at Lander, Wyoming, located about 100 miles north of Rock Springs. Lander experiences about 72% of the possible sunshine per year, ranging from 63% in the winter and spring to 78% in



Map SC2-1

Wyoming Climatic Divisions (dark lines) and Monitoring Stations (dots)
Used in Regional Coal Development Study
(Contour heights are in 500 meter intervals.)



the summer and fall (Wyoming Natural Resources Board 1966). On the western high plains and foothills to the Uinta and Wasatch Ranges (e.g., around Fort Bridger and Kemmerer), the sunshine would be expected to approximate the state's annual average of 65%.

Wind

A substantial data base of surface wind statistics recorded at sites within and appropriate to the ES region is not readily available. For the present study, five years of surface wind statistics for each of two stations were obtained to represent regional flow patterns. Data collected at Fort Bridger Airport, located in Uinta County, were selected to represent meteorological conditions in the proposed coal mining areas within Uinta and Lincoln Counties. Data recorded at Rock Springs Airport in Sweetwater County were chosen to depict the surface airflow patterns in the vicinity of the proposed Long Canyon and Black Butte mining areas.

Frequency of Wind Direction and Speed in Uinta and Lincoln Counties. Figure SC2-1 presents the annual wind rose for Fort Bridger, Wyoming. It is based on five years (1950 to 1954) of hourly wind observations. Fort Bridger is located in Uinta County about 35 miles east of the Utah-Wyoming state boundary at an elevation of 7,000 feet.

As indicated in Figure SC2-1, the prevailing wind direction at Fort Bridger is from the west-southwest and occurs 25% of the time. The annual average wind speed associated with this direction is 20 mph. The second most prominent (by frequency of occurrence) wind direction, west, is shown to occur more than 23% of the time and has an associated annual average speed exceeding 18 mph. Winds emanating from the west-southwest through the west-northwest (236 to 304°) occur about 64% of the time, with an average speed exceeding 18 mph annually. The annual average wind speed for all wind directions is 15 mph.

Calm conditions (wind speed < 2 mph) are relatively rare in the ES region as indicated by Fort Bridger data. Annually, they occur only 6% of the time. A slight seasonal variation ranges from a minimum of 5% (fall) to a maximum of 7% (winter).

Table SC2-1 presents the maximum number of hours of wind directional persistence at Fort Bridger for a five-year period (1950 to 1954). At Fort Bridger, the maximum periods of persistence are associated with those wind directions also occurring most frequently, with west-southwest and west winds showing periods greater than two days of persistence.

Frequency of Wind Direction and Speed in Sweetwater County. The City of Rock Springs, Wyoming, is located in Sweetwater County in the central portion of the ES region, about 65 miles east-northeast of Fort

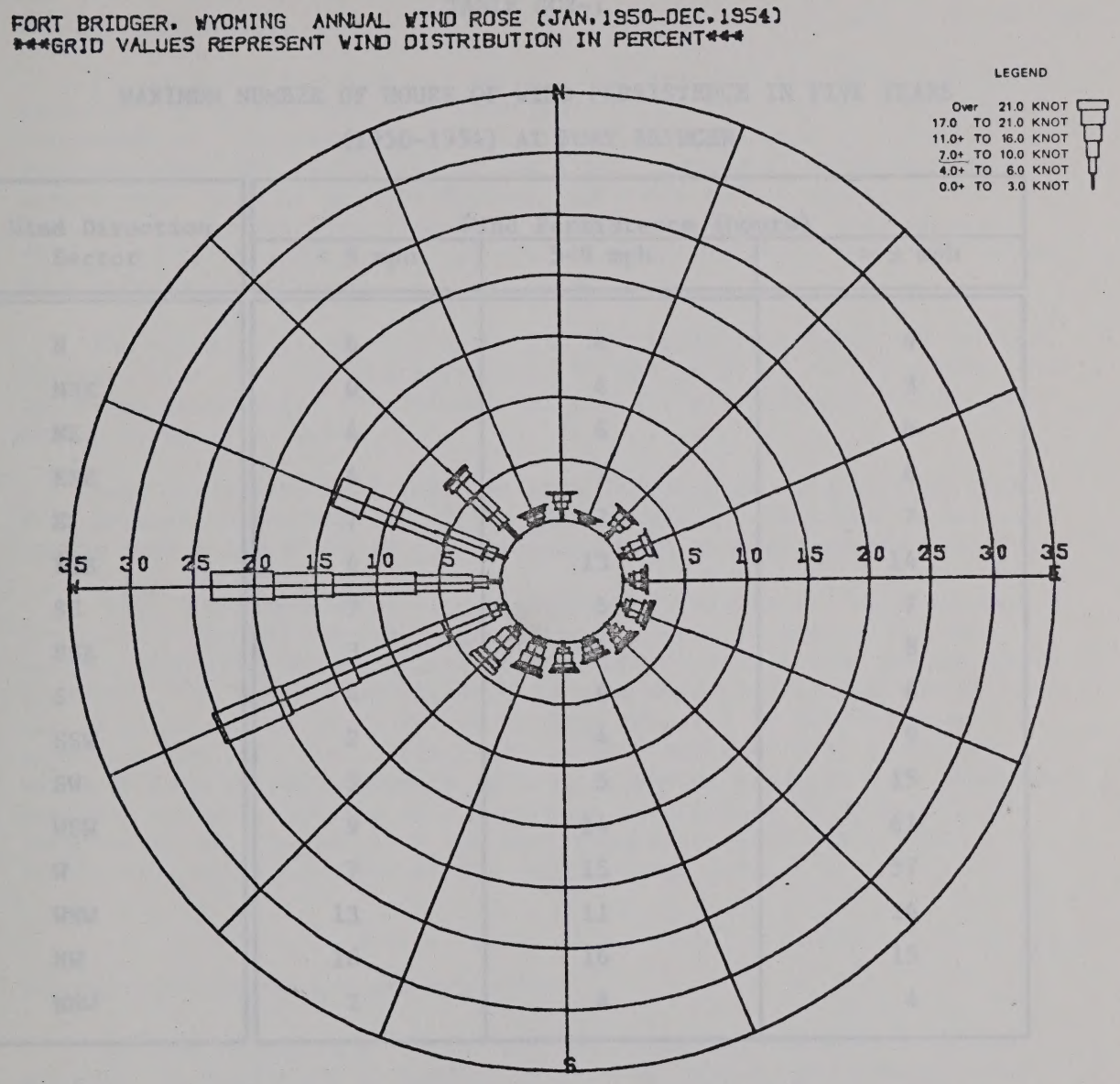


Figure SC2-1

Annual Wind Rose for Fort Bridger

1 knot = 1.15 mph

TABLE SC2-1

MAXIMUM NUMBER OF HOURS OF WIND PERSISTENCE IN FIVE YEARS (1950-1954) AT FORT BRIDGER

Wind Direction Sector	Wind Persistence (hours)		
	< 5 mph	5-9 mph	> 9 mph
N	6	4	4
NNE	0	4	3
NE	4	6	6
ENE	4	7	6
E	7	7	7
ESE	4	13	14
SE	7	5	7
SSE	3	4	8
S	4	6	6
SSW	2	4	9
SW	5	5	15
WSW	9	14	61
W	7	15	57
WNW	13	11	14
NW	16	16	15
NNW	2	4	4

Bridger. The city is situated at an elevation of about 6,400 feet above sea level. Rock Springs Airport, the wind observation site, is about 9 miles east of the city and 300 feet higher at an elevation of 6,700 feet.

Figure SC2-2 presents the annual wind rose for the Rock Springs Airport. It is also based on five years (1960 to 1964) of hourly wind observations. The prevailing direction at Rock Springs is from the west-southwest and occurs 18% of the time. Southwest winds are the second most frequent in Rock Springs and occur 16% of the time. Annually, the three wind direction sectors of southwest through west (214 to 281°) account for 50% of the hourly directional observations at Rock Springs Airport.

The annual average wind speed for all directions is 11 mph at Rock Springs, less than the characteristic 15 mph speed of Fort Bridger. For the three predominant directional sectors at Rock Springs, the average annual speed is 14 mph.

Calm conditions (< 2 mph) are more frequent at Rock Springs than Fort Bridger, occurring 11% of the time annually. Seasonal variation ranges from a low of 7% in the spring to more than 13% in the fall.

Table SC2-2 summarizes wind persistence results for Rock Springs for each of the sixteen wind direction sectors. It also gives the maximum number of hours of wind persistence in a five year period (1960 to 1964). The maximum persistence at Rock Springs during the five years was 32 hours, about one-half the maximum recorded at Fort Bridger. In addition, the period of maximum persistence occurred with northeast winds at Rock Springs compared to west-southwest winds at Fort Bridger. However, secondary maxima of directional persistence at Rock Springs occurred in association with the west component (southwest, west-southwest, and west) winds in the Rock Springs area.

Atmospheric Temperature and Stability

Surface Temperature. There are wide seasonal variations in temperature in southwestern Wyoming. In the ES region, the average mean maximum temperature (July) is ∿84°F, and the average mean minimum temperature (January) is ∿5.0°F. As indicated in Table SC2-3, the lowest temperature observed in the ES region was -34°F at Evanston, and the highest temperature of 97°F was recorded at both Rock Springs and Kemmerer.

Mean diurnal temperature variations for the same climatological stations for both January and July are presented in Table SC2-4. The average diurnal temperature variation in the ES region for January is ∿25°F, for July it is 36°F.

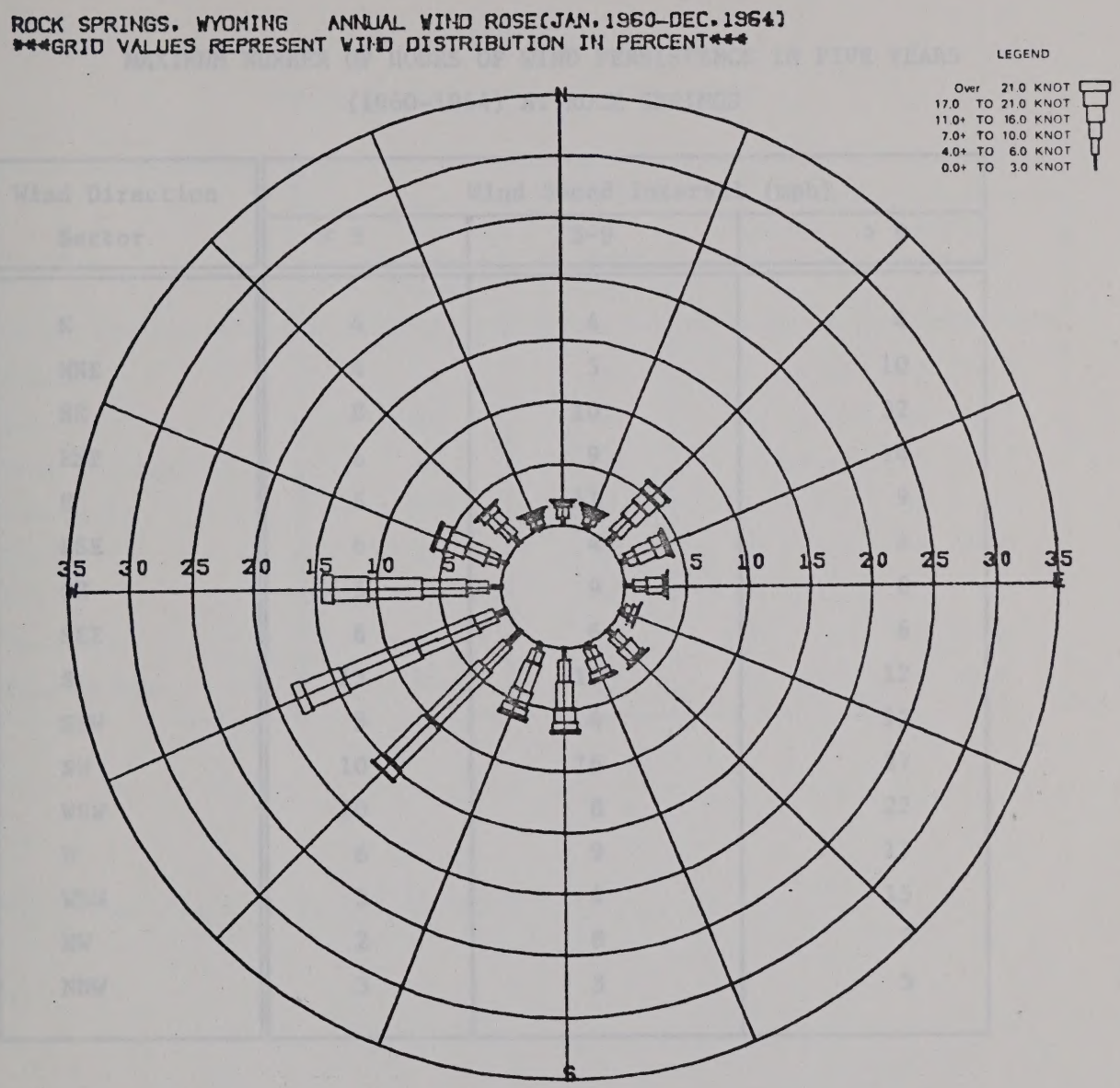


Figure SC2-2

Annual Wind Rose for Rock Springs

1 knot = 1.15 mph

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TABLE SC2-2

MAXIMUM NUMBER OF HOURS OF WIND PERSISTENCE IN FIVE YEARS (1960-1964) AT ROCK SPRINGS

Wind Direction Sector	Wind Speed Interval (mph)		
	< 5	5-9	> 9
N	4	4	4
NNE	4	5	10
NE	8	10	32
ENE	6	9	16
E	6	11	9
ESE	6	4	4
SE	5	9	8
SSE	6	6	6
S	13	11	12
SSW	5	4	12
SW	10	16	27
WSW	20	8	22
W	6	9	17
WNW	3	4	15
NW	2	8	7
NNW	3	3	5

TABLE SC2-3

SEASONAL VARIATIONS IN TEMPERATURE

Station	Temperature (°F)			
	Mean Maximum (July)	Mean Minimum (Jan)	Highest Observed	Lowest Observed
Kemmerer*	82	5	97 (Jun)	-32 (Feb)
Evanston*	81	4	94 (Jul)	-34 (Jan)
Rock Springs A.P.*	84	8	97 (Jul)	-29 (Jan)
Wamsutter	85	7	105 (Jul)	-38 (Jan)
Farson	84	-8	94 (Jul)	-46 (Feb)
Dixon	84	4	97 (Jul)	-50 (Jan)
Saratoga	84	8	100 (Jul)	-55 (Jan)
Seminoe Dam	84	12	97 (Jul)	-26 (Jan)

*Indicates stations in the ES region.

TABLE SC2-4

DIURNAL VARIATIONS IN TEMPERATURE

Station	Temperature (°F)					
	Mean Maximum		Mean Minimum		Diurnal Variation	
	Jan	Jul	Jan	Jul	Jan	Jul
Kemmerer*	29	82	5	44	24	38
Evanston*	30	81	4	44	26	37
Rock Springs A.P.*	29	84	8	53	21	31
Wamsutter	29	85	7	48	22	37
Farson	25	84	-8	44	33	40
Dixon	32	84	4	46	28	38
Saratoga	33	84	8	48	25	36
Seminoe Dam	30	84	12	54	18	30

*Indicates stations in the ES region.

Freeze Data. Table SC2-5 gives the average number of freeze-free days (for four threshold temperatures: 32, 28, 24, 20°F) for several climatological stations within the ES region.

Table SC2-6 gives the average length of the growing season for pasture grass (i.e., daily temperature 40°F or higher) for selected stations. In the ES region, the growing season for grass is generally longer than 185 days per year. Kemmerer's average growing season is 187 days and Green River's is 207 days.

Vertical Temperature Profile. The National Weather Service (NWS) monitors the vertical temperature profile twice per day at several stations throughout the country. Lander, Wyoming is the closest NWS location to the ES region that takes these readings. Two other NWS stations, Grand Junction, Colorado and Salt Lake City, Utah, located relatively near the ES region, also provide these data.

An analysis of five years (1960 to 1964) of radiosonde data at each of these locations suggests the following characteristics.

Morning Soundings.

- About 85% of all morning soundings (observation time at 5:00 A.M. Mountain Standard Time [MST]) indicate surface-based inversions.
- Two-thirds of these have an increase of temperature with height of >6°F per 1,000 feet.
- About 50% of these inversions are 800 feet or more deep.
- Surface-based inversions occur most frequently during the summer (June to August), but the deepest inversions are most likely to occur in the winter (December to February).

Afternoon Soundings.

- Less than 10% of the afternoon soundings (observation time 5:00 P.M. MST) have surface-based inversions.
- More than 75% of the surface-based inversions that do occur are more than 300 feet deep, but have an increase of temperature with height < 6.0°F per 1,000 feet.
- More than 50% of the afternoon soundings that have surface-based inversions are recorded during the winter months.
- About 25% of all afternoon soundings indicate upper-level inversions (i.e., an inversion with its base above ground-level).
- About 80% of these inversions are more than 800 feet thick.

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TABLE SC2-5

AVERAGE NUMBER OF DAYS BETWEEN THE LAST SPRING OCCURRENCE AND THE FIRST FALL OCCURRENCE OF VARIOUS FREEZE CONDITIONS

Station	Years	32°F	28°F	24°F	20°F
Afton	29	18†	54†	110	138
Casper A.P.	29	130	150	174	192
Diversion Dam	30	117	143	165	183
Dixon	29	83	114	141	167
Evanston 1E*	44	49†	95	131	158
Farson	39	59†	89	123	144
Green River*	43	101	132	159	183
Kemmerer*	17	60†	111	131	165
Leo 6SW	20	84	129	153	172
Pinedale	20	34†	69†	108	131
Riverton	29	121	142	164	185
Saratoga	30	80	112	137	162
South Pass City	30	11†	38†	76†	113

*Indicates stations in the ES region.

†Indicates that the threshold temperature can occur at any time.

Source: Probabilities of Freeze in Wyoming (Becker, Alyea, and Eppson 1961).

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TABLE SC2-6

GROWING SEASON FOR GRASS

Station	County	Date of 40° Mean Daily Temp		Length of Growing Season (days)
		Spring	Fall	
Afton	Lincoln	4/21	10/23	185
Bedford 2SE	Lincoln	4/21	10/24	186
Big Piney	Sublette	4/25	10/10	168
Border 3N*	Lincoln	4/17	10/23	189
Casper AP	Natrona	4/8	11/2	208
Diversion Dam	Fremont	4/7	10/30	206
Dixon	Carbon	4/9	10/26	200
Encampment 10ESE	Carbon	4/16	10/28	195
Evanston 1E*	Uinta	4/19	10/23	189
Farson	Sweetwater	4/16	10/19	186
Ft. Washakie 2S	Fremont	4/5	10/29	207
Green River*	Sweetwater	4/5	10/29	207
Kemmerer*	Lincoln	4/18	10/22	187
Lander AP	Fremont	4/7	10/30	206
Pathfinder Dam	Natrona	4/6	11/2	210
Pinedale	Sublette	5/2	10/13	164
Rawlins AP	Carbon	4/12	10/28	199
Riverton	Fremont	4/3	10/28	208
Sage 4NW*	Lincoln	4/18	10/20	185
Saratoga	Carbon	4/15	10/26	194
South Pass City	Fremont	5/8	10/8	153
Wamsutter	Sweetwater	4/11	10/25	197

*Indicates stations in the ES region.

Source: Trelease et al. 1970.

- The average lapse rate from the ground to the base of upper-level inversion is approximately adiabatic* (-5.4°F per 1,000 feet).

These characteristics are generally applicable to the ES region. However, since both Lander and Grand Junction are more sheltered by large topographic barriers than most of the ES region, the frequency and depths of surface-based inversions could be overestimated. A more detailed discussion is given in the Regional Technical Report, available at the Rock Springs District BLM office.

Turner Stability Data. Since most meteorological observation sites do not release radiosondes, and where they are used, a sounding analysis is only performed twice a day, an indirect method for determining hourly atmospheric stability is desirable. A widely accepted stability classification scheme was suggested by Turner (1964) to serve this function.

Table SC2-7 presents the frequency of occurrence for the major stability classes at Fort Bridger and Rock Springs, determined by the Turner system. The table presents annual and seasonal results determined from five years of hourly surface wind speed and cloud cover data.

Moisture

Total Precipitation. The average annual melted precipitation across the ES region is approximately 9.5 inches. However, there are pronounced topographic effects on precipitation, as can be seen in Map SC2-2. Mountain ranges (such as the Salt River, Wyoming, and Wind River) receive substantially more precipitation than the Bridger Basin.

Table SC2-8 tabulates mean monthly and annual precipitation for each reporting station. The means are based on over 30 years of data, compiled at each of the stations. Highest amounts of precipitation usually occur in spring and/or early summer (that is, in April, May, and/or June). However, even during this period, the monthly averages range from only 0.9 to 1.8 inches. More than half of the rainfall during this time of the year can be attributed to convective showers (which include thunderstorms).

Kemmerer and Evanston, both positioned on the lee side of the Bear River Divide, receive similar amounts of total precipitation and can be considered typical representatives of the western plains or foothill portions of the ES region. On the average, these sites receive more

*When a small volume of air is forced upward in the atmosphere, it encounters lower pressure, expands, and cools. If there is no heat exchange between the environment and this small volume (i.e., an adiabatic process), the rate at which cooling occurs during the ascent defines the dry adiabatic lapse rate.

TABLE SC2-7

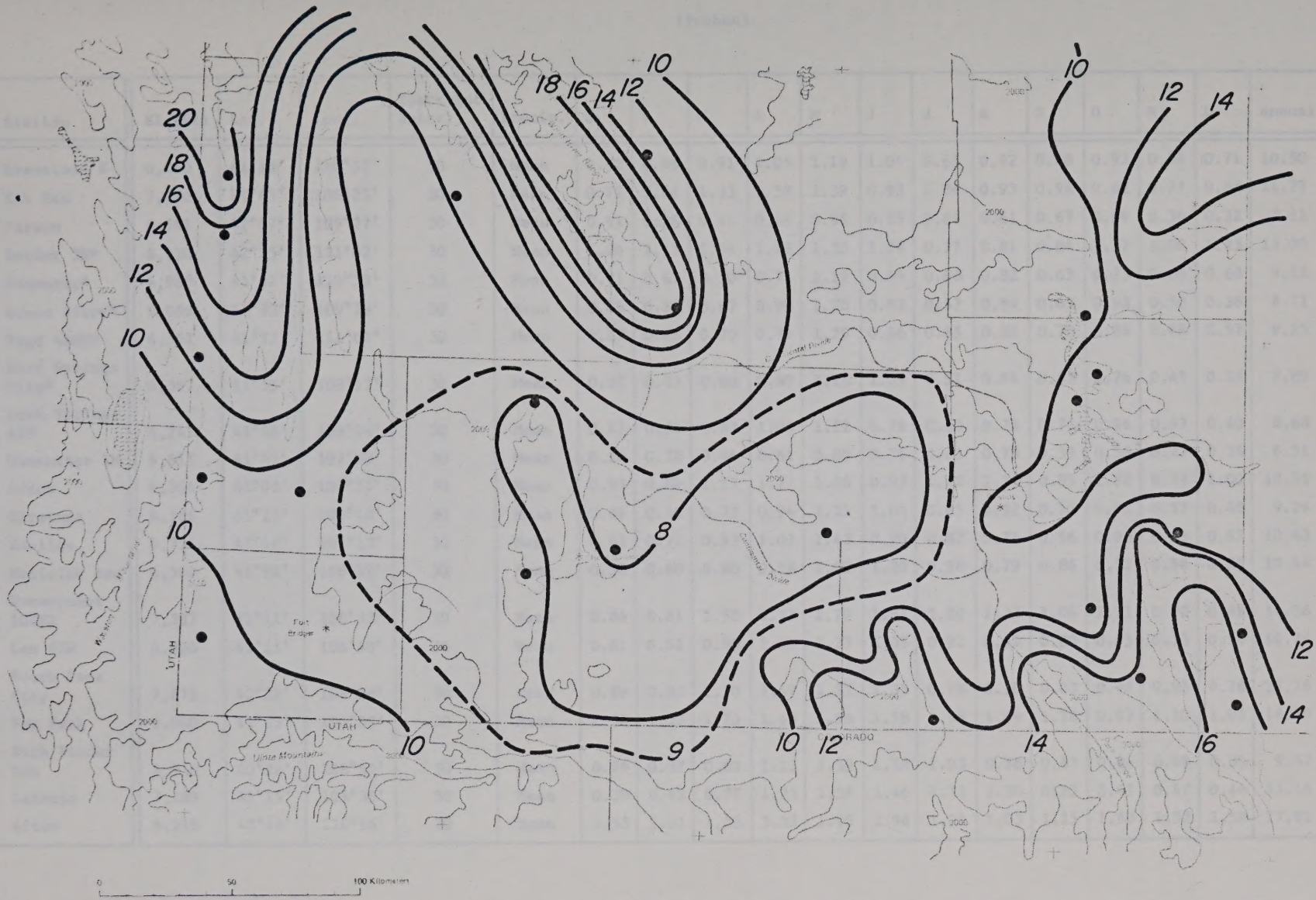
PERCENT FREQUENCY OF OCCURRENCE OF THREE STABILITY CLASSES
AT FORT BRIDGER AND ROCK SPRINGS
(%)

Fort Bridger

Period	Stability Class		
	Unstable	Neutral	Stable
Annual	13	68	19
Winter	7	79	14
Spring	10	72	16
Summer	23	54	23
Fall	12	66	22

Rock Springs

Annual	17	54	29
Winter	7	67	26
Spring	14	63	23
Summer	29	39	32
Fall	16	47	37



Map SC2-2

Normal Average Precipitation in Inches
(See Map SC2-1 for names of monitoring sites.)

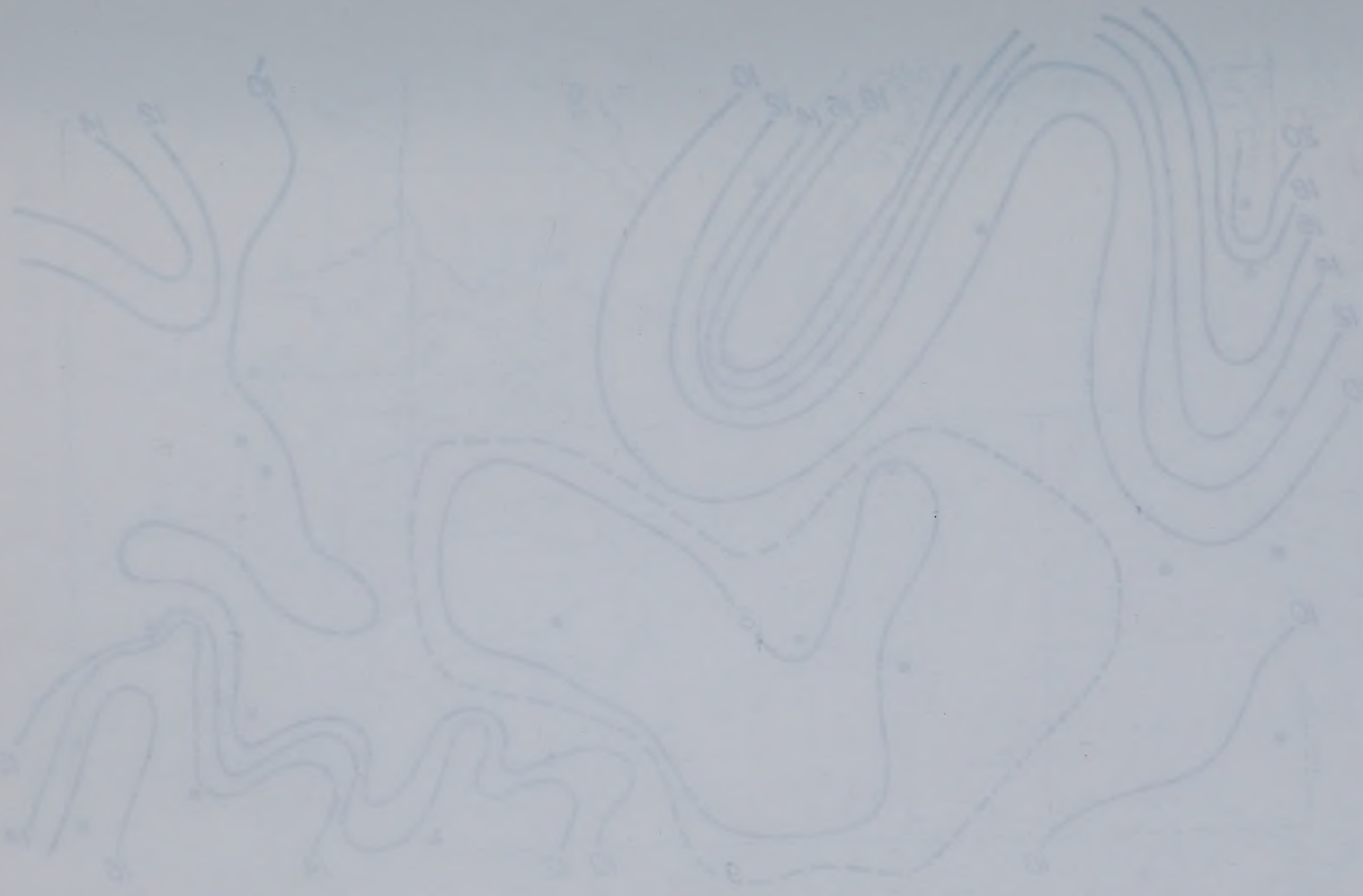


TABLE SC2-8

PRECIPITATION

(inches)

Station	El.(ft)	Lat.	Long.	Years (at least)	Precip.	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Evanston* E	6,860	41°16'	110°57'	30	Mean	0.72	0.86	0.91	1.05	1.19	1.04	0.65	0.92	0.68	0.93	0.84	0.71	10.50
Elk Mtn	7,270	41°41'	106°25'	30	Mean	0.72	0.86	1.33	1.58	1.39	0.98	0.84	0.93	0.94	0.82	0.77	0.63	11.79
Farson	6,591	42°07'	109°27'	30	Mean	0.41	0.46	0.45	0.69	0.96	0.85	0.64	0.61	0.67	0.69	0.36	0.32	7.11
Border 3N*	6,120	42°15'	111°02'	30	Mean	1.24	1.13	1.04	1.13	1.30	1.28	0.77	0.81	0.84	1.17	1.06	1.23	13.00
Kemmerer*	6,960	41°47'	110°32'	30	Mean	0.71	0.67	0.70	0.71	1.12	0.99	0.68	0.82	0.63	0.73	0.68	0.68	9.12
Green River*	6,089	41°32'	109°29'	30	Mean	0.49	0.52	0.67	0.99	1.20	0.92	0.57	0.84	0.65	0.98	0.50	0.38	8.71
Sage 4NNW*	6,321	41°52'	111°01'	30	Mean	0.67	0.66	0.70	0.79	1.20	0.96	0.65	0.85	0.70	0.84	0.66	0.57	9.25
Rock Springs City*	6,367	41°35'	109°13'	30	Mean	0.37	0.43	0.60	0.82	1.26	1.09	0.51	0.64	0.63	0.76	0.45	0.33	7.89
Rock Springs AP*	6,741	41°36'	109°04'	30	Mean	0.47	0.61	0.63	1.03	1.12	0.79	0.63	0.73	0.74	0.96	0.57	0.40	8.68
Wamsutter 1N	6,815	41°41'	107°59'	30	Mean	0.26	0.38	0.46	0.61	0.86	0.76	0.61	0.78	0.59	0.58	0.27	0.35	6.51
Dixon	6,364	41°02'	107°32'	30	Mean	0.93	0.69	1.17	1.27	1.26	0.95	1.22	1.14	0.85	1.28	0.79	1.00	12.55
Saratoga	6,786	41°27'	106°48'	30	Mean	0.46	0.40	0.72	0.94	1.25	1.04	0.85	0.97	0.75	0.91	0.52	0.48	9.29
Rawlins	6,736	41°48'	107°12'	30	Mean	0.62	0.71	0.93	1.07	1.43	0.90	0.87	0.76	0.96	0.98	0.53	0.67	10.43
Medicine Bow	6,560	41°54'	106°12'	30	Mean	0.58	0.60	0.80	0.98	1.60	1.30	0.98	0.79	0.86	0.82	0.58	0.55	10.44
Encampment 10ESE	7,387	41°11'	106°37'	30	Mean	0.84	0.81	1.50	1.73	1.79	1.31	1.20	1.33	1.06	1.21	0.90	0.88	14.56
Leo 6SW	6,000	42°11'	106°50'	30	Mean	0.61	0.62	0.98	1.29	1.37	1.05	0.91	0.91	0.80	0.95	0.73	0.54	10.76
South Pass City	7,875	42°28'	108°48'	30	Mean	0.89	0.91	1.10	1.49	1.32	1.35	0.78	0.70	0.83	0.98	0.85	0.76	12.16
Fox Park	9,060	41°05'	106°09'	30	Mean	1.38	1.37	1.70	1.68	1.56	1.58	1.68	1.49	1.16	0.97	1.10	1.03	16.70
Path Finder Dam	5,930	42°28'	106°51'	30	Mean	0.29	0.37	0.63	1.12	1.59	1.18	1.03	0.88	0.83	0.86	0.49	0.30	9.57
Laramie	7,189	41°19'	105°35'	30	Mean	0.39	0.42	0.77	1.25	1.54	1.46	1.73	1.20	0.82	0.67	0.47	0.44	11.16
Afton	6,210	42°44'	110°56'	30	Mean	1.53	1.51	1.55	1.52	1.95	1.96	1.06	1.05	1.15	1.53	1.52	1.59	17.92

*Indicates station in the ES region.

than 0.1 inches of precipitation in 29 and 34 days, respectively. Climatologically, stations located in the broad basin areas have fewer precipitation days. Two such sites, Farson and Rock Springs (City), record precipitation greater than 0.1 inches on only 19 days per year on the average.

Snowfall. Average snow depths reported monthly and annually are presented in Table SC2-9. Kemmerer and Evanston, located in the western foothills of the ES region, receive approximately 55 inches annually, whereas sites located in the broad basin areas such as Green River, Farson, and Rock Springs receive annual snowfalls of about 20 to 40 inches.

Evapotranspiration

Table SC2-10 presents the monthly, annual, and seasonal normals of precipitation and evapotranspiration for sites located in the ES region. The annual period shown in the table includes those months having mean monthly temperatures exceeding 32°F. The seasonal periods reflect the 32°F and 28°F frost-free periods at each of the sites.

This table indicates that there is a surplus of available moisture during the late fall and winter months, but a large deficit during the summer months. The annual deficit at Rock Springs and Kemmerer is -12.7 inches and -10.3 inches, respectively. In addition, when comparing this table with the dates for the growing season for grass (see Table SC2-6), it can be seen that periods of moisture deficit and the growing season roughly coincide.

Severe Weather Events

Thunderstorms. Within the ES region, thunderstorms occur most frequently during the spring and summer months. Generally, there is an increase in the frequency of thunderstorm activity from west to east in the ES region. About 30 thunderstorms a year occur near the Green River and Rock Springs area, and the number decreases to 25 at Evanston and Sage.

Occasionally these afternoon thunderstorms are accompanied by local gusty winds and hail. Far western stations such as Evanston and Kemmerer average only 3 to 3-1/2 hail days annually. This corresponds to the relatively lower number of thunderstorm days. East of the ES region around Saratoga, Elk Mountain, and Medicine Bow, the number of hail days increases to 4 annually.

Tornadoes are not of major concern in the ES region.

TABLE SC2-9

TOTAL SNOWFALL AT STATIONS IN ES REGION

(inches)

Station	Lat.	Long.	Period of Record (Years)	Elevation (feet)	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Border 3N*	42°15'	111°02'	D20	6,120	16.0	14.6	10.9	6.9	1.1	T	T	0	0.6	2.6	6.9	9.3	68.8
			G18		15.3	13.9	11.6	6.6	1.5	0.2	T	T	0.3	3.2	8.7	13.8	75.1
Dixon	41°02'	107°32'	D9	6,359	14.4	13.0	10.9	4.5	1.9	T	0	0	1.0	4.2	8.7	16.8	75.4
			G20		15.7	11.3	15.1	9.4	1.2	T	0	0	0.3	4.4	9.1	16.5	83.0
Elk Mountain	41°41'	106°25'	D24	7,103	19.9	26.7	21.7	21.5	10.4	0.1	0	0	2.7	11.3	9.8	17.7	141.8
			G17		10.6	9.6	19.2	16.8	3.7	0.7	T	T	1.1	4.6	8.8	9.4	82.5
Encampment 10ESE	41°11'	106°37'	D19	7,387	9.7	10.7	9.1	4.4	3.1	0.1	0	0	0.6	4.8	9.0	8.7	60.2
			G22		12.2	10.7	16.1	10.8	3.0	0.1	T	0	0.9	4.1	8.8	11.1	77.8
Evanston 1E*	41°16'	110°57'	D32	6,860	9.6	10.2	10.6	6.0	3.3	0.2	T	0	1.1	4.3	5.9	7.2	58.4
			G19		9.8	12.8	12.5	8.0	1.9	0.4	0	0	0.9	3.7	8.9	9.4	68.3
Farson	40°07'	109°25'	D19	6,600	3.3	4.6	2.9	2.4	0.5	T	0	T	0.3	1.1	2.2	3.1	20.4
			G16		5.5	5.7	6.3	5.3	1.8	0.2	T	0	0.1	2.8	5.2	4.4	37.3
Green River*	41°32'	109°29'	D23	6,109	4.9	5.4	4.8	3.2	1.2	T	0	0	0.2	2.4	3.8	3.5	29.4
			G18		6.2	7.3	7.5	7.3	2.2	0.2	0	0	0.1	3.7	4.1	5.0	43.6
Kemmerer*	41°48'	110°32'	G15	6,954	9.3	8.6	10.1	7.2	2.1	0.6	0	0	0.4	2.7	6.7	7.7	55.4
Leo 6SW	42°12'	106°50'	D11	6,000	9.9	8.4	9.2	4.4	3.3	0	0	0	0.8	3.7	3.5	8.6	51.8
			G19		11.3	8.5	10.9	9.2	2.9	0.8	0	T	0.8	3.3	7.9	7.5	63.1
Rawlins	41°47'	107°14'	D28	6,764	7.2	8.6	9.1	6.1	2.9	0.1	0	0	0.5	4.1	5.2	9.0	52.8
			G8		10.9	9.1	9.1	2.8	2.7	T	T	T	0.8	2.7	6.5	9.0	53.6
Sage*	41°49'	110°58'	D8	6,331	7.3	6.9	6.5	4.9	0.8	0	0	0	0.4	2.1	6.7	5.9	41.5
			G16		6.7	6.8	6.9	5.1	1.9	0.1	T	0	0.4	2.9	5.4	7.0	43.2
Saratoga	41°30'	160°47'	D26	6,794	10.1	8.6	9.6	5.3	4.3	0.1	0	0	0.3	3.3	5.0	8.3	54.9
			G21		7.0	6.0	8.1	7.1	2.5	0.3	0	0	0.8	0.3	5.8	7.3	48.0
Wamsutter 1N	41°41'	107°59'	G8	6,815	4.4	6.6	6.1	5.2	0.9	0.1	T	0	T	2.2	3.3	4.5	33.3
Rock Springs FAA AP*	41°36'	109°04'	37†	6,741	5.9	6.4	6.2	4.0	1.0	0.1	T	T	0.2	3.1	5.7	4.8	37.6

D = Means or extremes for the period of record prior to 1931.

G = Means or extremes for the period of record beginning with 1931.

*Indicates station in the ES region.

†From Wyoming Weather Facts (Wyoming Natural Resources Board 1966).

Source: U.S. Department of Commerce, undated.

TABLE SC2-10

NORMALS OF PRECIPITATION AND EVAPOTRANSPIRATION

(INCHES)

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	Season 32°	Season 28°
Evanston 1E															
P	0.7	0.9	0.9	1.1	1.2	1.0	0.7	0.9	0.7	0.9	0.8	0.7	10.5	*	2.5
PET	0.0	0.0	0.0	1.0	2.4	3.4	4.6	4.0	2.6	1.3	0.0	0.0	19.2	*	11.7
Farson															
P	0.4	0.5	0.5	0.7	1.0	0.9	0.6	0.6	0.7	0.7	0.4	0.3	7.1	*	1.9
PET	0.0	0.0	0.0	0.9	2.5	3.7	4.8	4.1	2.5	1.1	0.0	0.0	19.6	*	11.7
Green River															
P	0.5	0.5	0.7	1.0	1.2	0.9	0.6	0.8	0.7	1.0	0.5	0.4	8.7	2.5	3.4
PET	0.0	0.0	0.1	1.3	2.8	4.1	5.3	4.6	2.9	1.4	0.0	0.0	21.6	14.7	17.7
Kemmerer															
P	0.7	0.7	0.7	0.7	1.1	1.0	0.7	0.8	0.6	0.7	0.7	0.7	9.1	*	2.9
PET	0.0	0.0	0.0	1.0	2.5	3.5	4.6	4.0	2.5	1.2	0.0	0.0	19.4	*	13.7
Rock Springs Airport															
P	0.5	0.6	0.6	1.0	1.1	0.8	0.6	0.7	0.7	1.0	0.6	0.4	8.7	2.8	3.6
PET	0.0	0.0	0.0	1.0	2.6	3.9	5.2	4.6	2.8	1.3	0.0	0.0	21.4	15.8	18.0

P = Precipitation

PET = Potential Evapotranspiration

*No regular freeze-free period.

Source: U. S. Department of Commerce, and U. S. Soil Conservation Service, undated.

SW Ch. ____
Sec. ____
ERT ____
Cd. 3504 Pg. ____

Floods. Severe flooding is not a frequent event in the ES region. However, rapid runoff from heavy thunderstorm rains can cause flash flooding in headwater streams. When the rains coincide with the melting of the winter snowpack, flooding can intensify (Lowers 1960).

Droughts. A dry spell is defined as a two-week period when no measurable precipitation occurs (<0.01 inches). Since most of the ES is semiarid, dry spells are not unusual.

Droughts usually occur after several weeks of less-than-average precipitation. Severe or extreme droughts occur during 25% of the months in each year. This figure compares to values of less than 5% in places such as New England and the Pacific Northwest (Bryson and Hare 1974).

Blizzards. Snowfalls of 10 to 15 inches or more for any one storm occur infrequently outside mountainous areas (Lowers 1960). However, blowing and drifting snow associated with strong winter winds is not unusual even with light accumulations. Ground blizzards, the severe blowing and drifting of ground snowcover during clear periods that severely reduces surface visibility, can also occasionally occur.

DESCRIPTION OF AIR QUALITY

The southwestern Wyoming ES region lies within the Wyoming Intrastate Air Quality Control Region (AQCR), as designated by the U.S. Environmental Protection Agency (EPA). Currently, National Ambient Air Quality Standards (NAAQS) exist for total suspended particulates (TSP), sulfur dioxide (SO_2), carbon monoxide (CO), photochemical oxidants (O_x), and nitrogen oxides (NO_x). Additionally, there is a federal guideline for ambient nonmethane hydrocarbon (HC) levels. The State of Wyoming also has air quality standards, which include regulations applicable to all the above pollutants, as well as settleable particulates, coefficient of haze, sulfates, hydrogen sulfide, and fluorides.

The activities associated with the proposed mining would generate both vehicular emissions and fugitive dusts (particulates). Vehicular emissions could alter ambient CO, NO_x, HC, and SO_2 levels; and fugitive dust emissions would have an impact on ambient TSP levels. The gaseous emissions associated with proposed mining activities should have their greatest impact closest to the mines. However, the proposed expansion of the Naughton Power Plant and the expansion of the Jim Bridger Power Plant could affect the ambient levels of SO_2 and NO_x in addition to those for TSP. Consequently, the following analysis of present air quality will primarily address the ambient concentrations of TSP, since each activity (the mining and burning of coal as well as increased vehicular travel) can have a direct impact on the environmental levels of this pollutant. A less detailed analysis of the existing levels of the gaseous pollutants (SO_2, NO_2) will be given to describe expected baseline concentrations throughout the ES region.

Air quality data collected in southwest Wyoming during 1975 were used to establish baseline conditions. These TSP data for 1975 were statistically compared to 1976 TSP data for each of several state and private monitoring sites to determine any significant differences in TSP concentrations between the two years. Results indicate a significant difference in only four sites, all of which are explained by the movement of the monitor or increased activity in the area. Thus, it was concluded that in general the regional air quality measured by the monitors did not change significantly from one year to the next. Therefore, 1975 TSP data were assumed to be representative of the area and were used as a basis for the modeling study.

Air Quality Standards and Regulations

On 30 April 1971, the EPA promulgated primary and secondary NAAQS (Federal Register 1971). The primary standards were established to protect human health; whereas the secondary standards were established

to protect the public welfare from any known or anticipated adverse effects. The primary and secondary 24-hour or short-term standards for TSP, not to be exceeded more than once per year, are 260 and 150 $\mu g/m^3$, respectively. The annual or long-term limits are 75 and 60 $\mu g/m^3$. These are, respectively, the primary standard and a guideline rather than a secondary standard. An annual TSP concentration is defined as the geometric mean. The NAAQS for SO_2 are 1,300 $\mu g/m^3$, 365 $\mu g/m^3$, and 80 $\mu g/m^3$ for the 3-hour maximum, 24-hour maximum, and annual arithmetic mean, respectively. The 3-hour maximum is a secondary standard; the other two are primary standards. The short-term standards are not to be exceeded more than once per year. The annual limit established for NO_2 is 100 $\mu g/m^3$. The Clean Air Act Amendments of 1977 charged EPA with promulgating a 3-hour (or less) primary standard for NO_2 unless there is "no significant evidence" that such a standard is needed to protect public health.

On 22 January 1972, the State of Wyoming adopted air quality regulations that differed slightly from NAAQS. The state annual standard for TSP is 60 $\mu g/m^3$ (geometric mean) and the 24-hour standard, not to be exceeded more than once per year, is 150 $\mu g/m^3$. The annual SO_2 standard is 60 $\mu g/m^3$ (arithmetic mean) and the 24-hour standard, not to be exceeded more than once a year, is 260 $\mu g/m^3$. The state limit for NO_2 is the same as the NAAQS for NO_2. Table SC2-11 summarizes the State of Wyoming and federal ambient air quality standards for these pollutants.

In January 1972, the State of Wyoming classified the Wyoming Intrastate AQCR as Priority III for TSP, meaning that ambient air quality within this region was better than the state standards. On 7 December 1977, the State of Wyoming submitted its initial list of two nonattainment (NA) areas in the southwestern Wyoming ES region: the City of Rock Springs and the trona mining area, 6 miles north of Green River (Raffelson 1978). The EPA has modified the list to include only the trona mining area (Russell 1978).

All Prevention of Significant Deterioration (PSD) regulations apply to areas where air quality meets the state standards. These levels, designated for Class I, II, and III areas, are set to regulate incremental increases of TSP and SO_2 from new sources within Priority III regions according to the amount of energy or industrial growth desired. The following classes of desired growth were established by the EPA:

- Class I - areas where nearly any air quality deterioration would be considered significant, thus allowing little or no energy or industrial development.
- Class II - areas where deterioration that would normally accompany moderate, well-controlled growth would not be considered significant.

TABLE SC2-11

STATE OF WYOMING AND NATIONAL AMBIENT AIR QUALITY STANDARDS FOR CONCENTRATIONS OF TSP, SO_2, AND NO_2

Pollutant	Averaging Time	Standard ($\mu g/m^3$)		
		Federal		Wyoming
		Primary*	Secondary**	
TSP	Annual†	75	60§	60
	24-Hour††	260	150	150
SO_2	Annual§§	80		60
	24-Hour††	365		260
	3-Hour††		1,300	1,300
NO_2	Annual§§	100	100	100

*Requisite to protect human health.

**Requisite to protect the public welfare from any known or anticipated adverse effects.

†Geometric Mean

††Not to be exceeded more than once per year.

§Guideline

§§Arithmetic Mean

- Class III - areas where deterioration would be permitted to allow concentrated or very large scale energy or industrial development as long as the secondary NAAQS are not exceeded.

The State of Wyoming was initially classified a Class II area with the exception of five wilderness areas and two national parks larger than 6,000 acres, which have been classified manditory Class I. Of these seven Class I areas, only Bridger Wilderness Area, is located in southwestern Wyoming (see Map SC2-3). In addition to the existing Class I area, two proposed wilderness areas near the ES region could gain Class I status in the near future: Popoagie and Flaming Gorge National Recreation Area in Wyoming and High Uinta Primitive Area in Utah (Connor 1978). At present, neither the state of Wyoming nor the Wind River Indian Reservation has definite plans to reclassify any other areas of the state (Raffelson 1978).

Existing Ambient Air Quality

For the purpose of describing air quality, the ES region has been divided into three portions as follows:

- Western - this portion is bounded on the east by the Bridger Basin and on the north/south line through Lyman, Wyoming. The monitoring data collected in this western portion is descriptive of Kemmerer and its surroundings (see Map SC2-3).

- Central - this portion includes the urban sites of Rock Springs and Green River, as well as the industrial area known as the trona patch, located in the vicinity of Little America, Wyoming. Most of the air quality monitors used in this portion were installed to survey urban or industrial environments. However, its geographic character, like the other portions, is primarily rural, although the central portion is at times referred to as urban or industrial.

- Eastern - this portion starts east of the City of Rock Springs. Most of this monitoring data was collected in the vicinity of Point of Rocks, Wyoming and the Jim Bridger Power Plant. Again, reference to it as industrial is only used in relative terms, since the vast majority of the portion is rural.

The monitoring data used in this analysis were made available through the courtesy of several private corporations or government agencies. A telephone survey was made to inquire about instrument exposure, quality assurance procedures in data handling, and the purpose for choosing each monitor site. However, the volume of data and time constraints prevented a detailed secondary screening process to isolate

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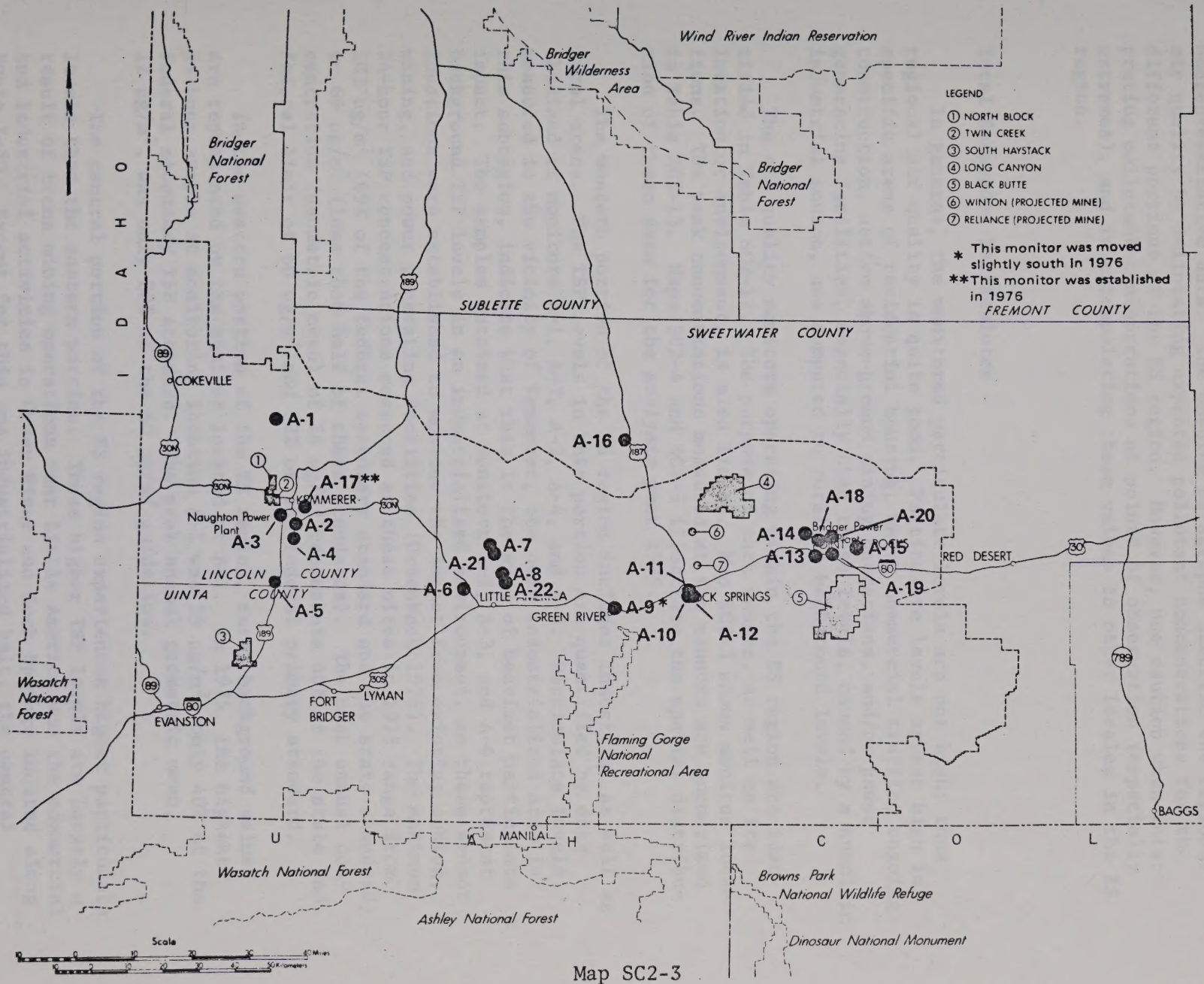


Map SC2-3

Location of Air Quality Monitors in Southwestern Wyoming

nonrepresentative data. The ensuing paragraphs describe the regional air quality by delineating expected pollutant concentrations for the different portions of the ES region. However, use caution when interpreting pollutant concentrations at points of observation (especially extremes), and in extrapolating these values to other locales in the ES region.

Total Suspended Particulates

In general, the monitored particulate levels are not high; thus regional air quality is quite good. Particulate levels appear high in specific areas of residential housing, heavy commercial traffic, ongoing construction, active above-ground mining operations, and/or power generating facilities, especially when these levels, caused by a specific industrial source, are compared to rural or background levels.

The air quality monitors operating within the ES region are identified in Table SC2-12. The purpose of each sensor, as well as its location or environment, is also listed. Map SC2-3 shows monitor locations. The peak concentrations measured at the sensors are summarized in Table SC2-13. Maps SC2-4 and SC2-5 illustrate the spatial distribution of these data for the analysis year 1975.

The western portion of the ES region includes industrial as well as rural areas. The TSP levels in this portion are quantified by data obtained at monitors A-1, A-2, A-3, A-4, and A-5. Particulate levels measured in the vicinity of Kemmerer, the only industrialized area in this subregion, indicate that this is the area of heaviest particulate impact. The samples obtained at monitors A-2, A-3, and A-4 represent background TSP levels in an industrialized environment, as these sensor locations were established to monitor the impact from existing coking, mining, and power generating facilities (Ursenbach 1976). The maximum 24-hour TSP concentrations measured at these sites in 1975 range from 103 $\mu g/m^3$ (69% of the federal secondary standard and the state standard) to 69 $\mu g/m^3$ (less than half of these standards). The peak annual concentration (geometric mean) of 24 $\mu g/m^3$ represents 40% of the state and federal limit of 60 $\mu g/m^3$ and 32% of the federal primary standard.

In the western portion of the ES region, rural background values are represented by the monitor located at A-1. In 1975, the highest 24-hour sample at monitoring location A-1 was 59 $\mu g/m^3$, only 40% of the federal secondary TSP standard. The peak annual geometric mean, 12 $\mu g/m^3$, was only 20% of the 60 $\mu g/m^3$ guideline.

The central portion of the ES region experiences higher particulate levels than the eastern portion. These higher TSP levels are largely a result of trona mining operations near Little America and the commercial and industrial activities in Green River and Rock Springs located along Route I-80. Except for this one industrialized belt, the central

TABLE SC-12

AIR QUALITY MONITORS IN SOUTHWESTEN WYOMING

Site Code	Monitor	Location	County	Portion of Region	Monitoring Purpose/ Environment	Private or State Operation	Pollutants Monitored at Site
A-1	Naughton, K-4	Kemmerer	Lincoln	West	Background/Rural	Private	TSP
A-2	Naughton, K-3	Kemmerer	Lincoln	West	Impact/Industrial	Private	TSP, SO_2
A-3	Naughton, K-2	Kemmerer	Lincoln	West	Impact/Industrial	Private	TSP, SO_2
A-4	Naughton, K-1	Kemmerer	Lincoln	West	Impact/Industrial	Private	TSP, SO_2
A-5	South Haystack		Lincoln	West	Background/Rural	Private	TSP
A-6	Don Lindsley*	Granger	Sweetwater	Central	Background/Residential	State	TSP
A-7	Texas Gulf No. 1	Little America	Sweetwater	Central	Background/Industrial	Private	TSP
A-8	FMC - Site A	Little America	Sweetwater	Central	Background/Industrial	Private	TSP
A-9**	Larry Clause*	Green River	Sweetwater	Central	Background/Residential	State	TSP
A-10	John Logan*	Rock Springs	Sweetwater	East	Background/Residential	State	TSP
A-11	Lyman Fearn*	Rock Springs	Sweetwater	East	Impact/Center City	State	TSP, SO_2
A-12	Robert Alder*	Rock Springs	Sweetwater	East	Background/Residential	State	TSP
A-13	Black Butte		Sweetwater	East	Background/Rural	Private	TSP
A-14	Bridger-Superior Wells	Point of Rocks	Sweetwater	East	Impact/Industrial	Private	TSP, SO_2, NO_2
A-15	Bridger-Microwave	Point of Rocks	Sweetwater	East	Impact/Industrial	Private	TSP, SO_2, NO_2
A-16	Sellers*	Eden	Sweetwater	North	Background/Rural	State	TSP
A-17†	Kemmerer	Kemmerer	Lincoln	West	Background/Rural	State	TSP, SO_2, NO_2
A-18	Bridger-Plant	Point of Rocks	Sweetwater	East	Impact/Industrial	Private	TSP, SO_2, NO_2
A-19	Bridger-Point of Rocks	Point of Rocks	Sweetwater	East	Impact/Industrial	Private	TSP, SO_2, NO_2
A-20	Bridger-Bluff Station	Point of Rocks	Sweetwater	East	Impact/Industrial	Private	TSP, SO_2, NO_2
A-21†	FMC - Site C	Little America	Sweetwater	Central	Impact/Industrial	Private	SO_2
A-22†	Texas Gulf - Site 4	Little America	Sweetwater	Central	Background/Industrial	Private	SO_2

*Private Residences

**Monitor A-9 was moved slightly south in 1976.

†Monitors established in 1976.

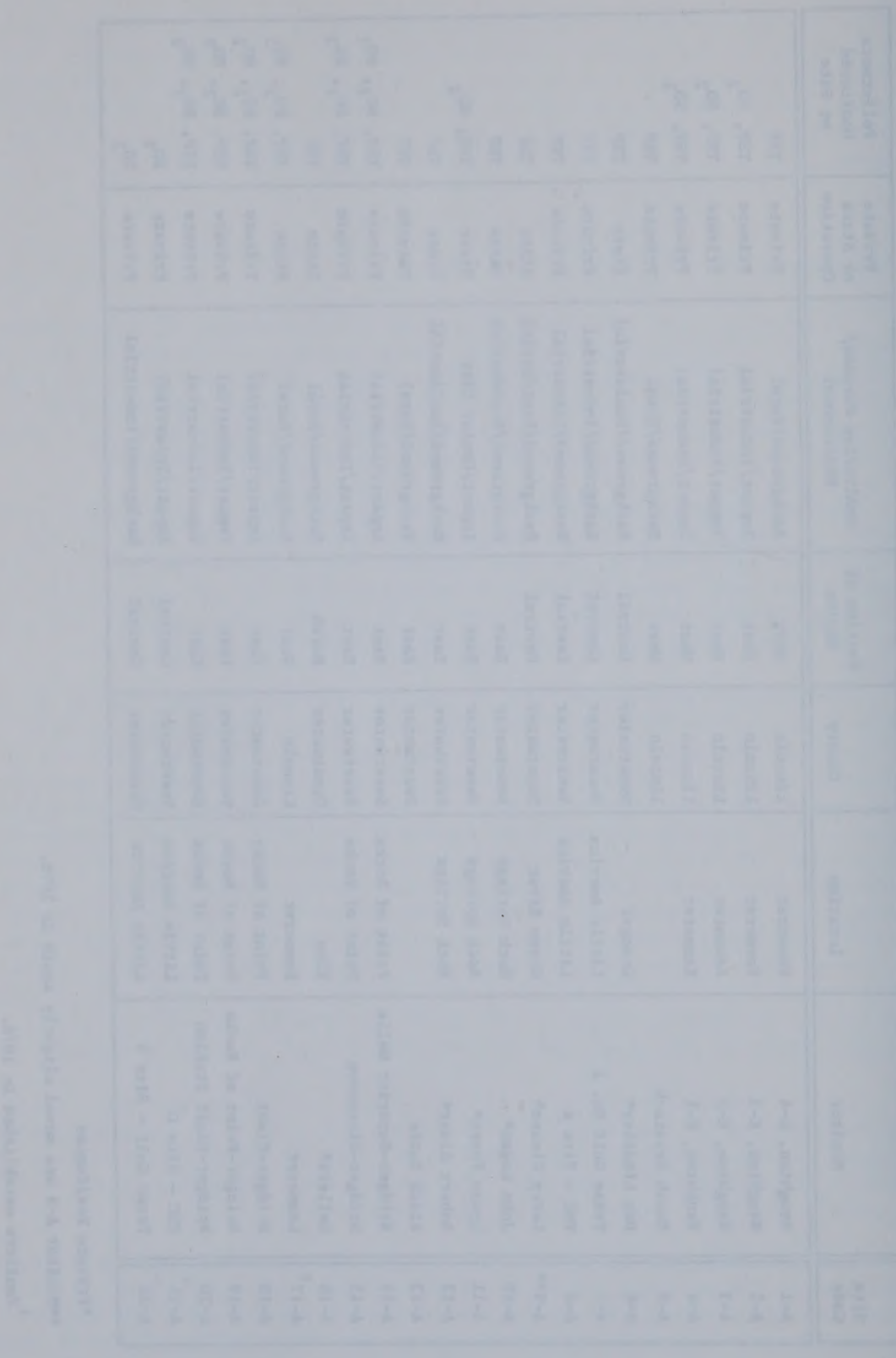


TABLE SC2-13

PARTICULATE CONCENTRATIONS MEASURED IN SOUTHWESTERN WYOMING*
($\mu g/m^3$)

Site Code	Sampling Year	Number of Observations**	Maximum 24-Hour Concentration	2nd Highest 24-Hour Concentration	Number of Violations of the Federal 24-Hour Standards†		Annual Geometric Mean
					Primary	Secondary	
A-1	1973	32	114	92	0	0	16
	1974	23	47	NA	0	0	22
	1975	22	59	44	0	0	12
	1976	27	51	47	0	0	15
A-2	1973	16	46	42	0	0	21
	1974	41	71	NA	0	0	34
	1975	45	103	86	0	0	21
	1976	30	74	71	0	0	18
A-3	1973	14	50	35	0	0	22
	1974	31	91	NA	0	0	39
	1975	40	83	77	0	0	20
	1976	32	75	61	0	0	26
A-4	1973	23	65	48	0	0	24
	1974	37	125	NA	0	0	53
	1975	46	69	58	0	0	24
	1976	33	78	77	0	0	34
A-5	1976	27**	68	64	0	0	28
A-6	1973	46	114	109	0	0	43
	1974	53	209	195	0	2	54
	1975	57	93	87	0	0	27
	1976	57	150	101	0	0	39
A-7	1974	49	59	43	0	0	21
	1975	60	53	45	0	0	16
	1976	59	57	53	0	0	19
A-8	1974	34	126	91	0	0	35
	1975	92	143	99	0	0	28
	1976	37	73	70	0	0	27
A-9	1975	49	119	115	0	0	46††
	1976	58	84	80	0	0	37††
A-10	1975	59	131	111	0	0	40
	1976	58	259	218	0	2	58
A-11	1972	45	271	240	0	1	119
	1973	50	321	277	3	20	118
	1974	52	347	308	7	18	115
	1975	57	231	207	0	11	90
	1976	58	248	218	0	9	100
A-12	1975	46	283	155	0	1	44
	1976	54	145	145	0	0	38
A-13	1975	34	43	26	0	0	13
	1976	60	37	33	0	0	13
A-14	1971-1972	NA	NA	NA	NA	NA	23
	1972-1973	NA	NA	NA	NA	NA	21
	1973-1974	NA	NA	NA	NA	NA	20
	1974-1975	71	167	162	0	1	24
	1975-1976	60	100	87	0	0	32
A-15	1971-1972	NA	NA	NA	NA	NA	31
	1972-1973	NA	NA	NA	NA	NA	22
	1973-1974	NA	NA	NA	NA	NA	14
	1974-1975	69	64	57	0	0	14
	1975-1976	55	95	91	0	0	19
A-16	1975	28	63	39	0	0	16
	1976	52	94	50	0	0	19
A-17	1976	15	45	30	0	0	13
A-18	1971-1972	NA	NA	NA	NA	NA	53
	1972-1973	NA	NA	NA	NA	NA	61
	1973-1974	NA	NA	NA	NA	NA	80
	1974-1975	67	805	787	5	13	87
	1975-1976	56	1135	526	9	16	56

TABLE SC2-13 (Continued)

PARTICULATE CONCENTRATIONS MEASURED IN SOUTHWESTERN WYOMING*
($\mu g/m^3$)

Site Code	Sampling Year	Number of Observations**	Maximum 24-Hour Concentration	2nd Highest 24-Hour Concentration	Number of Violations of the Federal 24-Hour Standards†		Annual Geometric Mean
					Primary	Secondary	
A-19	1974-1975	41	121	112	0	0	23
	1975-1976	54	59	48	0	0	25
A-20	1974-1975	15	76	47	0	0	33
	1975-1976	55	303	113	0	1	32

NA means not available.

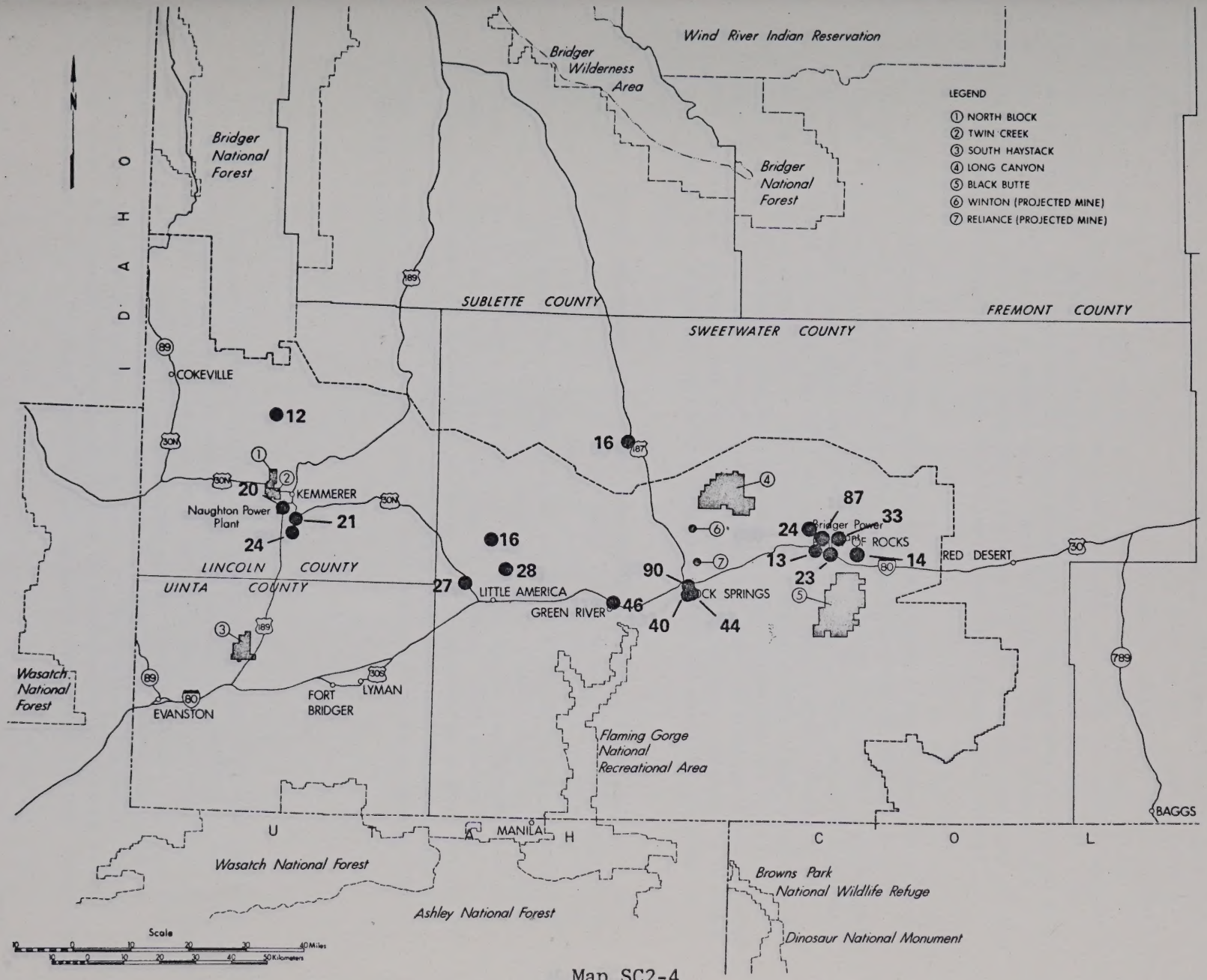
*See Table SC2-12 and Map SC2-3 for description of monitor location and environment.

**Samples were obtained approximately every six days.

†See Table SC2-11.

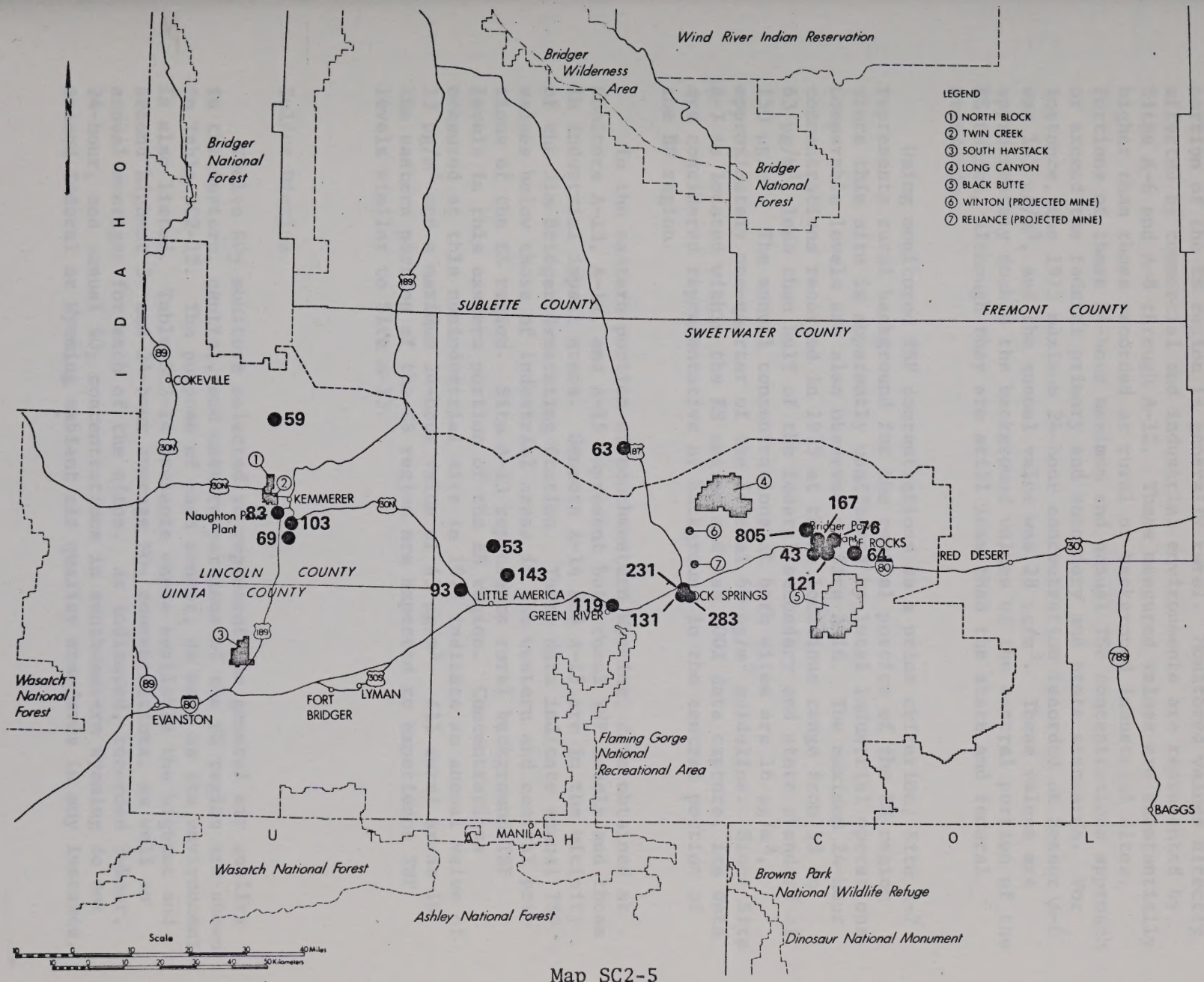
††Average of four quarterly geometric means.

SW Ch. ____
Sec. ____
ERT ____
Cd. ____ Pg. ____



Map SC2-4

1975 Annual Geometric Mean TSP Concentrations Monitored in Southwestern Wyoming



Map SC2-5

1975 Maximum 24-Hour TSP Concentrations Monitored in Southwestern Wyoming

portion of the ES region is generally rural. Monitored values directly affected by commercial and industrial environments are represented by Sites A-6 and A-8 through A-12. These measured values are substantially higher than those recorded at rural or background industrial sites. Portions of these 24-hour maximum and annual TSP concentrations approach or exceed the federal primary and secondary and state standards. For instance, the 1975 maximum 24-hour concentration recorded at Sensor A-8 was 143 $\mu g/m^3$, and the annual value was 28 $\mu g/m^3$. These values are approximately double the background values of the central portion of the ES region, although they are still less than the state and federal standards.

Using monitored TSP concentrations as a prime criterion, Site A-7 represents rural background for the central portion of the ES region since this site is apparently unaffected by local industrial operations. Comparable levels are also observed at Site A-16. The maximum 24-hour concentrations recorded in 1975 at these locations range from 53 to 63 $\mu g/m^3$, less than half of the federal secondary and state standard of 150 $\mu g/m^3$. The annual concentrations at both sites are 16 $\mu g/m^3$, approximately one-quarter of the federal 60 $\mu g/m^3$ guideline. Since Site A-7 is located within the ES region and has 100% data capture, its data are considered representative of background in the central portion of the ES region.

In the eastern portion of southwestern Wyoming, data obtained at Monitors A-13, A-14, and A-15 represent both rural TSP levels and those in industrial impact areas. Sensors A-14 and A-15 are in the vicinity of the Jim Bridger Generating Station. These data indicate annual TSP values below those of industrial areas in the western and central portions of the ES region. Site A-13 represents rural background TSP levels in this eastern portion of the ES region. Concentrations measured at this nonindustrial site in 1975 indicate an annual value of 13 $\mu g/m^3$ and a maximum 24-hour value of 43 $\mu g/m^3$. All rural areas in the eastern portion of the ES region are expected to experience TSP levels similar to Site A-13.

Sulfur Dioxide

Twelve SO_2 monitors selected to represent the general air quality in the western, central, and eastern portions of the ES region are shown in Table SC2-12. The purpose of each sensor, as well as its environment is also listed. Table SC2-14 presents where available the highest and second highest 3- and 24-hour average SO_2 concentrations, as well as annual averages for each of the sites. As indicated, recorded 3-hour, 24-hour, and annual SO_2 concentrations in southwestern Wyoming do not exceed federal or Wyoming ambient air quality standards in any instance.

TABLE SC2-14

CONCENTRATIONS OF SO_2 MEASURED IN SOUTHWESTERN WYOMING
(µg/m3)

Site	Sampling Year	No. Observations		Maximum Concentration		2nd Highest Concentration		No. Violations of the Federal Standard		Arithmetic Mean
		1-Hour	Daily	3-Hour	24-Hour	3-Hour	24-Hour	3-Hour	24-Hour	
A-2	1975-1976	8,491	350	115	24	86	21	0	0	2
A-3	1975-1976	7,514	304	89	14	89	11	0	0	0.7
A-4	1975-1976	8,056	331	105	26	100	22	0	0	3
A-11*	1972		29		20		20		0	4
	1973		42		12		8		0	3
	1974		46		10		5		0	1
	1975		59		10		10		0	2
	1976		36		9		8		0	1
A-14**	1974-1975		-		NA		NA		NA	<2.6 (9 months)†
	1975-1976		NA		NA		NA		NA	2.6
A-15**	1974-1975		NA		NA		NA		NA	<2.6 (9 months)
	1975-1976		NA		NA		NA		NA	2.6
A-17*	1976		10		5		2		0	1
A-18	1974-1975		NA		NA		NA		NA	<2.6 (9 months)
	1975-1976		NA		NA		NA		NA	2.6
A-19**	1974-1975		NA		NA		NA		NA	<2.6 (6 months)
	1975-1976		NA		NA		NA		NA	2.6
A-20**	1974-1975		NA		NA		NA		NA	5.2 (3 months)
	1975-1976		NA		158		117		0	10.4
A-21	1974	226	-	309	131		128	0	0	NA
	1975	6,704	-	197	98		77	0	0	NA
	1976	5,102	-	197	99		62	0	0	NA
A-22	1976		9		3		3		0	NA

NA means not available.

*SO_2 gas bubbler providing 24-hour average alone.

**Short-term data not readily available.

†Sampling duration.

In the western portion of the ES region, the maximum 24-hour SO_2 concentrations measured in 1975 to 1976 ranged from 14 $\mu g/m^3$ (4% of the federal and 5% of the state standard) to 26 $\mu g/m^3$ (7% of the federal and 10% of the state standard).

Similarly, the 3-hour peaks are less than 10% of the state and federal standards of 1,300 $\mu g/m^3$. The peak annual concentration (arithmetic mean) of 3 $\mu g/m^3$ represents 4% and 5% of the federal and state standards, respectively.

Since ambient SO_2 concentrations are more dependent on local anthropogenic sources than TSP levels, the more rural portions of the ES region (not directly impacted by an isolated source) should more clearly indicate lower SO_2 concentrations. In 1976, the state installed an SO_2 gas bubbler east of Kemmerer (Site A-17) to monitor background SO_2 levels. The 24-hour concentrations monitored at this site are lower than those previously mentioned, but the ten observations are insufficient and seasonally biased to be considered significant. However, that the peak 24-hour SO_2 concentrations observed are on the order of the resolution of the instrument threshold does suggest that levels in these rural areas should be minimal in comparison to ambient standards.

Monitors for SO_2 in the central portion of the ES region are situated near Little America in the basin referred to as the trona patch. Monitor A-22 is located slightly northeast of Little America on an isolated mesa southeast of the Texas Gulf Plant. Data collected at this sensor should represent the general background levels of this industrial area and not the direct plant emissions. Only nine observations were made at this station in 1976, giving insufficient data from which to draw conclusions. However, as with site A-17, preliminary data from A-22 suggests that background SO_2 levels in the area should be safely below short-term standards, with peak values at or below the resolution of the instrument.

Northwest of monitor A-22 is the FMC monitor A-21. This sensor is positioned 3,000 feet to the east of the FMC plant, and data collected at this site should represent the direct impact from the facility. The maximum 24-hour SO_2 concentration recorded in 1976 is 99 $\mu g/m^3$, 27% of NAAQS and 388% of the state standard.

Another state SO_2 bubbler (A-11) is located in the City of Rock Springs. It was installed to survey ambient SO_2 levels in this central Wyoming population district. The peak 24-hour concentration recorded at this site was 20 $\mu g/m^3$ in 1972. The annual mean in that year was 4 $\mu g/m^3$, only 5% of the corresponding federal standard. Since SO_2 levels in the most industrialized portion of the central ES region are below standards, it is assumed that background SO_2 concentrations in the more rural areas are also within federal and state established limits.

The SO_2 monitors in the eastern portion of the ES region are located in the vicinity of the Jim Bridger Power Plant. These samplers collect data on plant emissions. Unit A-20, Bluff Station, is situated directly downwind (east) of the Jim Bridger Plant; thus, it records the greatest levels of SO_2 in the Bridger network. The maximum 24-hour concentration measured in 1976 at A-20 is 158 $\mu g/m^3$ (43% and 61% of federal and state standards, respectively). The peak annual concentration (arithmetic mean) is 10.4 $\mu g/m^3$ (13% of federal and 17% of Wyoming standards). Annual average concentrations at A-14, A-15, A-18, and A-19 were at or below 2.6 $\mu g/m^3$.

In summary, ambient SO_2 levels are generally very low throughout the ES region. On occasion, at certain locations, short-term SO_2 concentrations can peak in association with plume passage emanating from an isolated point source. However, the available data suggests that these higher, short-term SO_2 levels are local, within ambient standards, and atypical of the ES region as a whole. Annual SO_2 concentrations appear to range from only 5 to 15% of the state and federal standards.

Nitrogen Dioxide

A very limited amount of NO_2 data is available for the ES region because of the small number of monitoring sites in the area. Table SC2-15 summarizes the available data. Station A-17 represents rural background concentrations of NO_2 on the outskirts of the town of Kemmerer. The maximum 24-hour concentration is reported as 14 $\mu g/m^3$, and the annual arithmetic mean is reported as 7 $\mu g/m^3$, only 7% of the federal and state primary standard of 100 $\mu g/m^3$.

The other five monitoring stations represent industrial background NO_2 levels and range from 2 to 24 $\mu g/m^3$. Monitor A-20 was installed directly downwind of the Jim Bridger Power Plant to measure impact of the plant's emissions. Measurement of NO_2 at the plant site (A-18) and Point of Rocks site (A-19) are thought to be closely related to local and highway traffic patterns, respectively. Diurnal peaks at these latter sites are early morning coincident with increased traffic levels and cold stable air at the surface (Crow and Hadley 1975). However, no violations of the federal NO_2 annual standard were found in the ES region.

Visibility

The data sets used for estimating background visibility consisted of five years of hourly visual observations taken at both the Fort Bridger (1950 to 1954) and Rock Springs (1960 to 1964) Airports.

TABLE SC2-15

CONCENTRATIONS OF NO_2 IN SOUTHWESTERN WYOMING
($\mu g/m^3$)

Site	Sampling Year	No. Observations	Max. 24-Hr Conc.	2nd Highest 24-Hr Conc.	No. Violations of Federal Annual Std.	Annual Arithmetic Mean
A-17	1976	9	14	12	0	7
A-14	1974-1975	NA	NA	NA	0	<2
	1975-1976	NA	NA	NA	0	2
A-15	1974-1975	NA	NA	NA	0	<2
	1975-1976	NA	NA	NA	0	2
A-18	1974-1975	NA	NA	NA	0	4
	1975-1976	NA	NA	NA	0	4
A-19	1974-1975	NA	NA	NA	0	14
	1975-1976	NA	NA	NA	0	24
A-20	1974-1975	NA	NA	NA	0	4
	1975-1976	NA	NA	NA	0	4

NA means not available.

Horizontal Visibility from Airport Observations. Visual observations are made of physical objects at known distances. These data sets document discrete ranges in horizontal visibility from zero (< 1/16 mile) to greater than 100 miles (unlimited). Obscurations to horizontal visibility (such as fog, haze, smoke, or blowing dust) are manditorily recorded only if visibility is limited to less than 7 statute miles during a given hourly period. Table SC2-16 presents the number of hours and percent frequency of occurrence of horizontal visibility observations in seven distance ranges for both the Fort Bridger and Rock Springs Airports. As indicated, Fort Bridger and Rock Springs had a total of 21,932 and 21,989 hours of visibility observations during the daylight hours of their respective five-year records.

Prominent topographic features at a distance of 41 to 50 miles from both the Fort Bridger and Rock Springs Airports appear to be easily referenced in visual observations, since about 57 and 67%, respectively, of all daytime observations were tabulated in that range at each site. Otherwise, visual range was evenly distributed between 11 and 40 miles at Fort Bridger. However, a secondary peak in the frequency of visual observations between 11 and 20 miles was observed at the Rock Springs site. This secondary peak in visual range likely results from another prominent landmark in the airport observer's line of sight, instead of a discontinuity caused by a real optical phenomenon.

There were no observations of blowing dust or sand that restricted visibility to less than 7 miles at either Fort Bridger or Rock Springs during their respective five-year recording periods. The visibility was restricted by smoke and/or haze during only six and four hours at Fort Bridger and Rock Springs, respectively. In addition, both fog and blowing snow significantly reduced visibility during less than 1% each of the total daylight hours at the two airports. Rain and snow, although occurring relatively infrequently, appear to be the mechanisms that limit horizontal visibility most frequently in the ES region.

In summary, visual range in the ES region is good. The coincidence of the modal differential frequencies at the two airport sites is not significant, but that more than one-half of all visual observations at each site exceeds 40 miles suggests that it would be a minimum distance reasonable for the definition of a background visual range in southwest Wyoming.

TABLE SC2-16

FIVE-YEAR SUMMARY OF HORIZONTAL VISIBILITY IN ES REGION

Horizontal Visibility (miles)	Fort Bridger			Rock Springs		
	Number of Daylight Observations	Differential Frequency (%)	Cumulative Frequency (%)	Number of Daylight Observations	Differential Frequency (%)	Cumulative Frequency (%)
>50	451	2.06	2.06	56	0.26	0.26
41-50	12,490	56.95	59.01	14,639	66.57	66.83
31-40	3,079	14.04	73.05	45	0.20	67.03
21-30	2,828	12.89	85.94	336	1.53	68.56
11-20	1,700	7.75	93.69	5,495	24.99	93.55
6-10	639	2.91	96.60	623	2.83	96.38
$\leq$5	745	3.40	100.00	795	3.62	100.00
Total	21,932	100.00	100.00	21,989	100.00	100.00

FUTURE ENVIRONMENT WITHOUT THE PROPOSED ACTION

Climate

From a review of the climatological data available, there are no obvious indications that the climate of Wyoming over the next fifteen years will differ from what exists at the present time. In addition to the proposed coal development activities addressed in this report, other projects like the proposed expansion of Naughton Power Plant and the expansion of the Jim Bridger Power Plant are scheduled for completion during this time. However, given the data available at the present time, no judicious estimate can be made of their potential adverse impact, if any, on the regional climate.

Air Quality

An estimate of the probable increases in particulate and fugitive dust emissions in the ES region was made in the Chapter 4 Regional Technical Report, available at the Rock Springs District BLM Office. These estimates were projected through 1990. Subsequently, the baseline TSP monitoring data, in concert with scaling factors derived from these projections, were used to estimate future TSP concentrations. Note that the following data includes population growth associated with the proposed actions. Consequently, the estimate of future air quality does not include the direct impact of the proposed actions alone and are somewhat conservative. The lack of resolution in the baseline data (both population and air quality) prevents a more precise distinction between the scenarios addressing indirect air quality impact and future environment without the proposed actions.

Map SC2-3 indicates that each of the proposed mining sites is to be located in a rural area. In addition, each is displaced either in a favorable upwind position or at a sufficient downwind distance from concentrated industrial activity to have the local air quality also described as rural. On the contrary, the immediate vicinities of Rock Springs, Green River, or Kemmerer (which display a mix of residential, commercial, and industrial influences), or the trona patch near Little America (which houses numerous industrial activities) have to reflect TSP levels characteristic of their more anthropogenically influenced environments.

For example, in the vicinity of Rocks Springs, TSP levels are expected to increase as a result of increases in local traffic and construction activity. Particulate levels are also expected to increase in the trona patch because of expansion of the Allied Chemical Plant. Available data indicate that the Allied plant will emit 657 tons per

year additional particulates after expansion and, assuming continuous operation, an increase of approximately 45% over its 1975 particulate emissions level of 1,432 tons per year. The expansion of the Jim Bridger Power Plant and the proposed expansion of Naughton Power Plant are expected to increase particulate emissions at maximum load by 325 pounds per hour (∿25%) and 262 pounds per hour (∿20%), respectively.

Thus, ground level TSP concentrations should increase in all areas, but not in a homogeneous spatial pattern, as suggested by emissions burden considerations alone. Other factors, such as meteorology, source geometry, and topography, all exert external influences of varying degrees on ambient TSP levels. Consequently, a range of baseline TSP concentrations typical of rural, industrial, and urban areas was evaluated. Concentrations of TSP representative of a 24-hour averaging period were based on second highest levels observed, since these levels are appropriate for comparison with the state and federal short-term standards.

Projections of urban (or industrial) impact or background concentrations were made in the following four-step process:

1. Selecting a representative TSP range for the baseline case;

2. Separating the estimated contribution of rural background from the urban or industrial contribution;

3. Scaling the composite parts individually; and

4. Recombining the scaled rural background component to the scaled urban or industrial component.

Figures SC2-3 and SC2-4 present the results through a series of bar graphs depicting the approximate ranges of 1975 through 1990 TSP levels for annual and 24-hour averaging periods, respectively. The projected rural background should be generally representative of the ES region, except for the few urban and/or industrial areas previously discussed. The TSP levels calculated for 1990 are assumed representative for the several years following, primarily because substantive emissions data for post 1990 are unavailable. However, urban TSP emissions display a downward trend after 1980 because of the expected slow down in construction activity. Consequently, it is anticipated that TSP air quality would not deteriorate significantly (if at all) during the period of the proposed actions after 1990.

As indicated by these figures, the range in expected TSP concentrations is quite large and tends to display overlap between the various generic classes (i.e., rural, industrial, or urban). However, the range of rural background concentrations should not be as exaggerated as urban or industrial impact areas and should primarily reflect differences in site exposure, local soil conditions, or plant cover, which, in turn, regulate the naturally induced emissions of fine particles in the atmosphere.

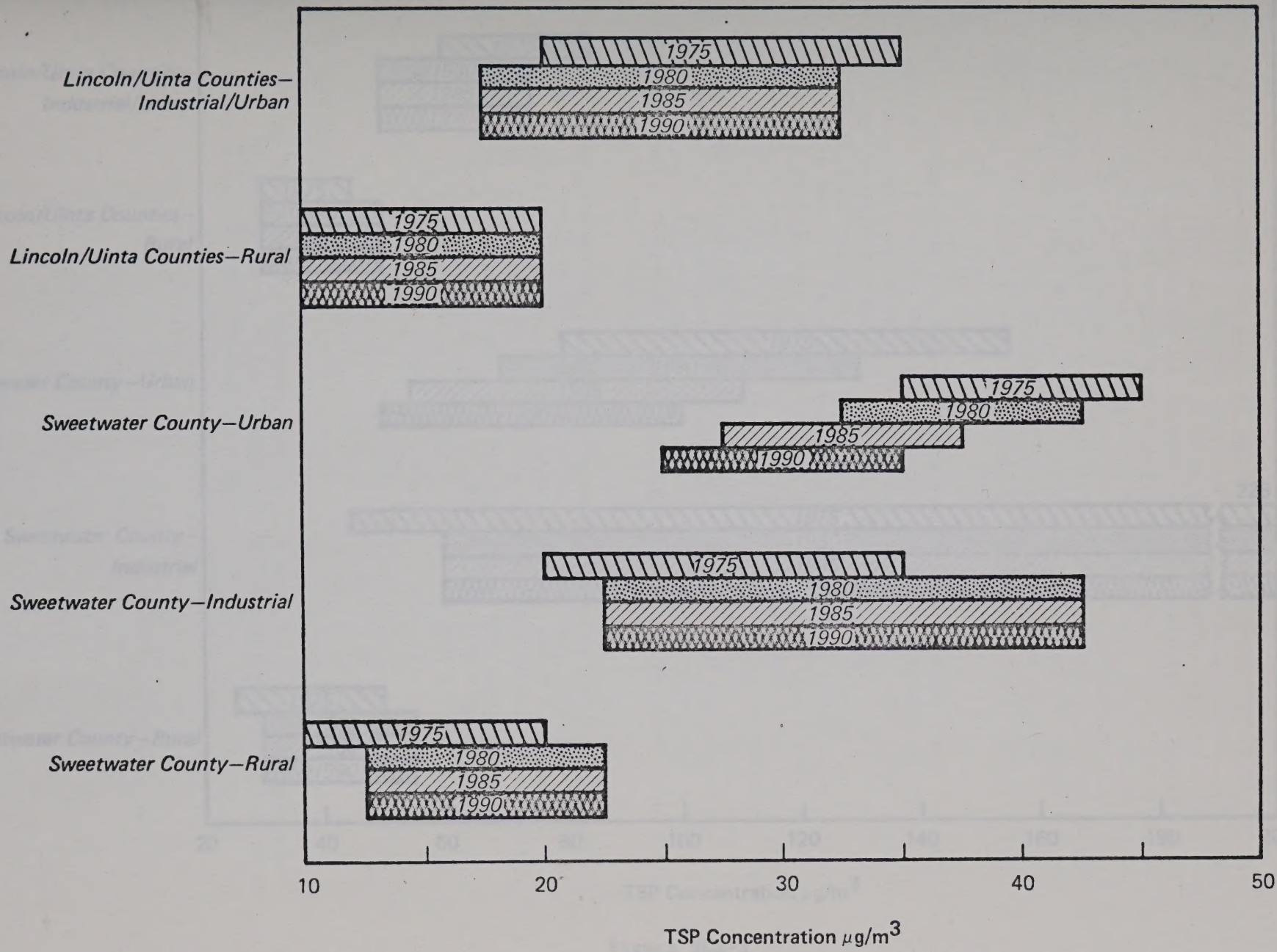


Figure SC2-4

Ranges in Annual Background TSP Concentrations in ES Region

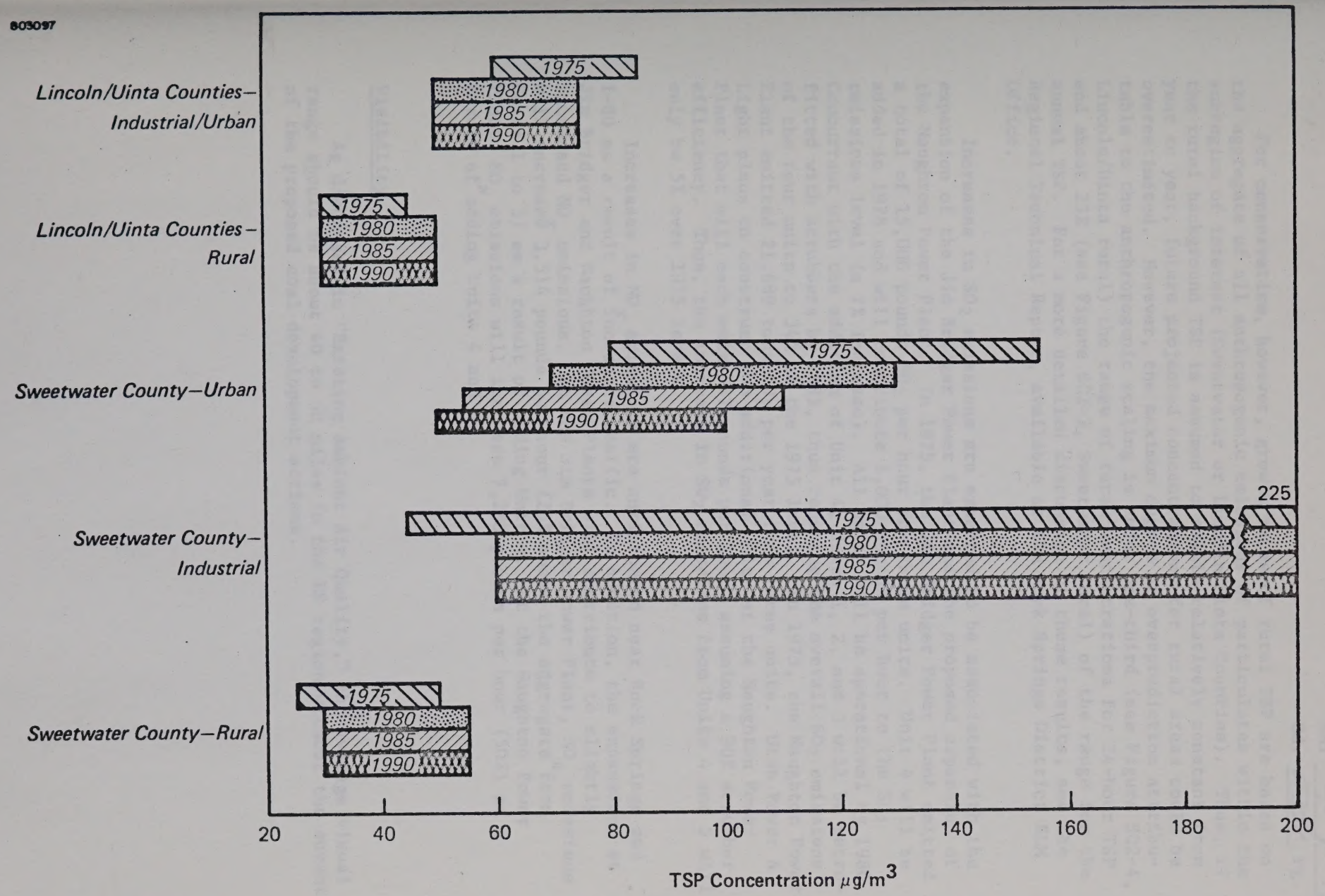
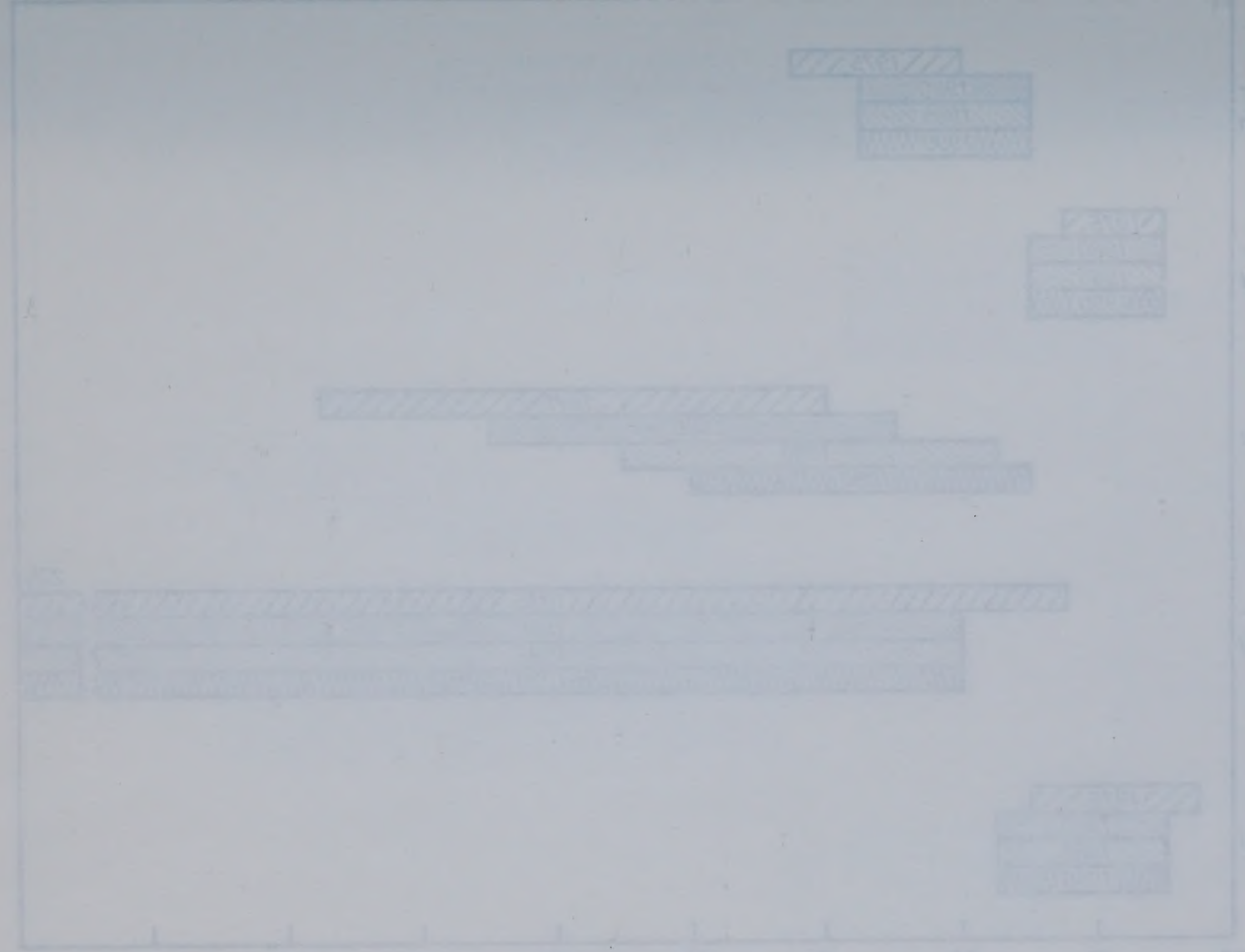


Figure SC2-3

Ranges in 24-Hour Background TSP Concentrations in ES Region



For conservatism, however, growth rates of rural TSP are based on the aggregate of all anthropogenic emissions of particulates within the subregion of interest (Sweetwater or Lincoln/Uinta Counties). Thus, if the rural background TSP is assumed to remain relatively constant from year to year, future projected concentrations for rural areas could be overestimated. However, the maximum degree of overprediction attributable to the anthropogenic scaling is about one-third (see Figure SC2-4, Lincoln/Uinta rural) the range of rural concentrations for 24-hour TSP and about 25% (see Figure SC2-3, Sweetwater rural) of the range for the annual TSP. For a more detailed discussion of these results, see the Regional Technical Report, available at the Rock Springs District BLM Office.

Increases in SO_2 emissions are expected to be associated with the expansion of the Jim Bridger Power Plant and the proposed expansion of the Naughton Power Plant. In 1975, the Jim Bridger Power Plant emitted a total of 15,000 pounds SO_2 per hour for three units. Unit 4 will be added in 1978 and will contribute 1,000 pounds per hour to the SO_2 emissions level (a 7% increase). All units will be operational by 1980. Concurrent with the addition of Unit 4, Units 1, 2, and 3 will be retrofitted with scrubbers by 1985, thus reducing the overall SO_2 emissions of the four units to 34% of the 1975 level. In 1975, the Naughton Power Plant emitted 21,689 tons SO_2 per year from three units. Utah Power & Light plans to construct two additional units at the Naughton Power Plant that will each emit 547 pounds per hour, assuming a 90% scrubber efficiency. Thus, the increase in SO_2 emissions from Units 4 and 5 will only be 5% over 1975 levels.

Increases in NO_x emissions are anticipated near Rock Springs and I-80 as a result of increased traffic. In addition, the expansions at Jim Bridger and Naughton Power Plants will contribute to slightly increased NO_x emissions. At the Jim Bridger Power Plant, NO_x emissions will increase 3,514 pounds per hour (25% above the aggregate from Units 1 to 3) as a result of adding Unit 4. At the Naughton Power Plant, NO_x emissions will increase 7,280 pounds per hour (50%) as a result of adding Units 4 and 5.

Visibility

As discussed in "Existing Ambient Air Quality," the average visual range should be about 40 to 50 miles in the ES region without the advent of the proposed coal development actions.

AIR QUALITY MITIGATING MEASURES

The proposed coal development activities in southwestern Wyoming will be governed by a number of state and federal regulations pertaining to surface coal mining and air quality. A brief discussion of each regulation and its application to coal development in the ES region follows.

Surface Mining and Reclamation Regulations

The proposed mining operations and associated reclamation activities will be conducted under the Mineral Leasing Act (41 Stat. 437, as amended; 30 U.S.C. 181 ct seq), the Mineral Leasing Act for Acquired Lands (61 Stat. 913, 30 U.S.C. 351-359) and the Federal Land Policy and Management Act of 1976 (90 Stat. 2743; 43 U.S.C. 1701-1771).

These three laws are implemented by the Bureau of Land Management (BLM) and the U.S. Geological Survey (USGS) under the following regulations.

1) Title 43 CFR Part 3041

   These regulations provide the procedures to avoid, minimize, or correct damages to the environment, including land, water, and air during exploration or surface mining of federal coal (and other minerals). The regulations also ensure that hazards to public health and safety are avoided, minimized, or corrected.

2) Title 43 CFR Part 3500

   These regulations provide the procedures to conduct leasing and subsequent management of federal coal (and other minerals).

3) Title 30 CFR Part 211

   These regulations govern operations for discovering, testing, developing, mining, and preparing federal coal under leases, licenses, and permits in compliance with 43 CFR Part 3500.

The Surface Mining Control and Reclamation Act of 1977 (PL 95-87) regulates federal surface coal mining operations and the acquisition and reclamation of abandoned mines for other purposes. This act is implemented by the Office of Surface Mining under the regulations in Title 30 CFR Part 700. The act and regulations provide the following:

- environmental protection performance standards that describe procedures for maximizing removal of the coal resource, stabilizing surface areas to control erosion and emissions of fugitive dust, and restoring the condition of the mined land;
- inspection and enforcement procedures, including civil penalties for mining operations and reclamation activities;
- procedures for state and federal designation of areas unsuitable for surface coal mining operations and lands unsuitable for noncoal mining; and
- requirements and procedures for approval of state mining permits.

The proposed mining operations and associated reclamation activities in the ES region will be constrained by these regulations.

Air Quality Regulations

The major regulations pertaining to air quality include the Clean Air Act Amendments of 1977 (PL 95-95), National Ambient Air Quality Standards (NAAQS), New Source Performance Standards (NSPS), the Wyoming Environmental Quality Act of 1973, and the Wyoming Ambient Air Quality Regulations.

The Clean Air Act of 1970 specified that each state would be responsible for achieving and maintaining air quality within its borders and for specifying the way it would be achieved and maintained (ERT 1977).

On 30 April 1971, the EPA promulgated the primary and secondary NAAQS (Federal Register 1971). The primary standards were established to protect human health, whereas the secondary standards were established to protect the public welfare from any known or anticipated adverse effects. Standards were put into effect for TSP, SO_x, NO_x, CO, HC, and photochemical oxidants. In the ES region, TSP, SO_2, and NO_x are the pollutants of major interest.

The primary and secondary 24-hour or short-term standards for TSP, not to be exceeded more than once per year, are 260 and 150 $\mu g/m^3$, respectively. The annual or long-term limits are 75 and 60 $\mu g/m^3$. These are, respectively, the primary standard and a guideline rather than a secondary standard. An annual TSP concentration is defined as the geometric mean. The NAAQS for SO_2 are 1,300 $\mu g/m^3$, 365 $\mu g/m^3$, and 80 $\mu g/m^3$ for the 3-hour maximum, 24-hour maximum, and annual arithmetic mean, respectively. The 3-hour maximum is a secondary standard; the other two are primary standards. The short-term standards are not to be

exceeded more than once per year. The annual limit established for NO_2 is 100 $\mu g/m^3$. The Clean Air Act Amendments of 1977 charged EPA with announcing a 3-hour (or less) primary standard for NO_2 unless there is "no significant evidence" that such a standard is needed to protect public health.

Wyoming ambient air quality standards were put into effect in accordance with the Wyoming Environmental Quality Act. On 22 January 1972, the State of Wyoming adopted air quality regulations that were slightly more stringent than the NAAQS. The state annual standard for TSP is 60 $\mu g/m^3$ (geometric mean), and the 24-hour standard, not to be exceeded more than once per year, is 150 $\mu g/m^3$ (U. S. Department of Commerce 1975). Wyoming SO_2 standards are also somewhat stricter than federal regulations. The state annual standard for SO_2 is 60 $\mu g/m^3$ (arithmetic mean) and the 24-hour standard, not to be exceeded more than once a year, is 260 $\mu g/m^3$. The state limits for NO_2 are the same as the NAAQS for NO_2. The Wyoming DEQ, Air Quality Division, is empowered to enforce these air quality standards.

The Clean Air Act of 1970 mandated division of each state and appropriate interstate area into Air Quality Control Regions (AQCRs). The Clean Air Act Amendments of 1977 require the states to identify regions within the AQCRs that do not meet the NAAQS by 7 December 1977 to determine which areas are governed by PSD standards or by NA requirements.

On 7 December 1977, the State of Wyoming submitted its initial list of two NA areas in the ES region: the City of Rock Springs and the trona patch 6 miles north of Green River. Within each of these areas, monitors have recorded violations of the state and federal annual TSP standards (Raffelson 1978). The EPA modified the list to include only the trona patch since TSP violations in Rock Springs are very localized and caused by fugitive dust rather than a major point source (Russell 1978).

The Clean Air Act Amendments of 1977 strengthened the enforcement mechanisms for PSD standards and for attainment of standards in NA areas. The original mid-1975 deadline for attainment of primary air quality standards has largely slipped, and Congress has established a stringent new time table. Each state must submit by January 1979 a revised SIP that specifies how primary standards will be achieved by 1982. If a state fails to submit an approval plan to EPA, no permit for a new or modified major plant can be issued after 1 July 1979 (ERT 1977).

PSD regulations apply to areas where air quality meets the state standards. They are intended to manage incremental increases of TSP and SO_2 from new sources according to the amount of energy or industrial growth desired. Three classes of desired growth were established by the EPA:

- Class I - applies to areas where nearly any air quality deterioration would be considered significant, thus allowing little or no energy or industrial development.

- Class II - applies to areas where deterioration that would normally accompany moderate, well-controlled growth would not be considered significant.
- Class III - applies to areas where deterioration would be permitted to allow concentrated or very large scale energy or industrial development as long as the secondary NAAQS are not exceeded.

The State of Wyoming was initially classified a Class II area with the exception of five wilderness areas and two national parks larger than 6,000 acres, which have been classified manditory Class I. Of these seven Class I areas, only Bridger Wilderness Area is located in the ES region. In addition to the existing Class I area, three proposed wilderness areas near the ES region could gain Class I status in the near future: Popoagie in Wyoming, High Uinta Primitive Area in Utah (Connor 1978), and Flaming Gorge National Recreation Area in Wyoming. At present, neither the state of Wyoming nor the Wind River Indian Reservation has definite plans to reclassify any other areas of the state (Raffelson 1978).

The Clean Air Act Amendments of 1977 (Section 111) contain major revisions of the Clean Air Act of 1973 regarding NSPS for stationary sources. These revisions fall into five categories: (1) definitions, (2) specific actions, (3) the role of the states, (4) design or equipment standards, and (5) waivers for innovative technology. Standards, when proposed or officially announced, are published in the Federal Register.

AIR QUALITY IMPACTS

Fugitive Dust Emissions from Coal Mining

Development of the proposed actions will impact air quality in southwest Wyoming. Specifically, existing pollutant concentrations such as total suspended particulates (TSP), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), hydrocarbons (HC), and carbon monoxide (CO) will be affected. Coal mining, in general, is a significant source of particulate emissions, and its impact on SO_2, NO_2, HC, and CO is relatively small. To determine the change in TSP concentrations caused by the most probable level of mining development in southwestern Wyoming, it is necessary to estimate the quantity of TSP emitted into the atmosphere. Any disturbance of the earth's surface or movement of material generates dust. If the dust is not prevented from becoming airborne at the source, it is called fugitive dust. Once in the air, some fugitive dust particles will be large enough to fall out rapidly near the source. The remainder have slower settling rates and are considered suspended particles. Many of the operations associated with coal mining constitute significant sources of fugitive dust that, in turn, contribute to elevated ambient particulate levels in the vicinity of the mine. Activities analyzed in this study are enumerated below.

- Overburden removal and handling associated with interim storage at spoils dumps
- Removal of coal from seam and truck loading
- Truck dumping of coal
- Crushing and screening
- Coal transfer operations
- Haul road and access road traffic and maintenance operations
- Wind erosion from disturbed and exposed land
- Reclamation operations
- Wind erosion from aggregate storage of coal

It is evident that some of these activities overlap. For example, overburden removal and storage necessarily involve truck dumping and wind erosion from spoils dumps.

In general, the emission factors used in the current investigation for the various mining activities were obtained from the EPA document (1977) and the PEDCo (1976) report. It is emphasized that the factors presented in these reports were, for the most part, taken directly from several previous studies. It is important to note that the reliability of these emissions factors, in general, has been rated "poor" by the EPA

(1977). Such factors are qualified as supportable by best engineering judgment, involving visual observation and judgmental adjustments to results of emission tests conducted at noncoal mining sources. It is evident, therefore, that errors and inconsistencies may arise from two sources. The first of these is represented by dissimilarities between the prototype coal mine (not accounted for in the adjustments) on which the EPA factor is based and the nonmining activities where the sampling occurred. The second is the potential dissimilarity between the prototype coal mine and the ES region mines. The geological and soil characteristics, as well as the modes of operation at these sites, may bear little resemblance to the proposed mines in the ES region that were analyzed.

Mine-specific information was, for the most part, obtained from the latest available draft version of Chapter 1 of this ES (including the regional report), as well as verbal consultation with the Rock Springs office of the BLM and mine personnel.

Contributions to the annual particulate emissions burden from the various fugitive dust sources at each of the five proposed mines and the projected mines are given in Tables SC4-1, SC4-2 and SC4-3. Although these emission rates are given as yearly averages, all activities are not continuous. As such, they are approximations of the complex interaction of variables that affect pollutant emissions. From the tables, the following observations are apparent.

- In general, wind erosion from unreclaimed land constitutes the most significant single source of fugitive dust from the surface mines, accounting for 20 to 50% of the total. These figures, however, are based on the assumption that planting would begin in the Fall, that surface roughness and sheltering effects are negligible, and that mulching and planting are performed in a one-step operation.

- Overburden removal and storage operations appear to be the most important sources of emissions except for wind erosion, accounting for about 25 to 40% of total fugitive emissions. It is noted that overburden removal constitutes 68% of the total emissions for Black Butte in the final year of coal mining because of the inordinately large amount of overburden material (200 million tons) that must be displaced.

- Emissions from haul and access road traffic at the surface mines range from 10% of the total at Twin Creek and Black Butte to about 30% at South Haystack for those years when overburden haulage would be occurring. Unpaved road emissions would only be about 3% of the total for both South Haystack and Twin Creek during those years when overburden would not be hauled.

1980 PARTICULATE EMISSIONS FROM COAL MINES IN ES REGION

(tons per year)

	North Block	Twin Creek	South Haystack	Black Butte	Long Canyon	Winton*	Reliance*	Total
Overburden Removal	-	648	382	1,121	NA			2,151
Ore Loading	-	125	75	270	25			495
Truck Dumping	-	25	15	54	5			99
Train Loading	NA	2.5	1.5	5.4	0.5			9.9
Conveying	-	12.5	7.5	27	2.5			49.5
Coal Storage	NA	0.7	0.4	1.5	3.4			6.0
Crushing (primary)	-	1.2	0.8	2.7	0.2			4.9
Crushing (secondary)	-	4	2.4	8.6	NA			15.0
Overburden Dump Disturbance	-	255	240	NA	NA			495
Employee Access Roads	33	1.4	38	43	70.5			186.2
Haul Roads (coal)	-	105.5	15.5	357	NA			478
Haul Roads (overburden)	-	359	570	NA	NA			929
Haul Road Repair	-	56	56	56	NA			168
Dozers (overburden dumps)	56**	81	56	224	NA			417
Wind Erosion	245	729	624	1,020	135			2,753
Total	334	2,405	2,084	3,190	242			8,256

NA means not available.

- Particular operation not active in 1980.

*These mines are not operational in 1980.

**Associated with initial construction activities.

1985 PARTICULATE EMISSIONS FROM COAL MINES IN ES REGION

(tons per year)

	North Block	Twin Creek	South Haystack	Black Butte	Long Canyon	Winton*	Reliance*	Total
Overburden Removal	133	648	763	1,435	NA	NA	NA	2,979
Ore Loading	70	125	150	330	100	100	25	900
Truck Dumping	14	25	30	66	20	20	5	180
Train Loading	NA	2.5	3.0	6.6	2	2	0.5	16.6
Conveying	7	12.5	15	33	10	10	2.5	90
Coal Storage	NA	0.7	0.8	1.8	13.5	0.5	0.1	17.4
Crushing (primary)	0.7	1.2	1.5	3.3	1.0	1.0	0.2	8.9
Crushing (secondary)	5.6	4	4.8	10.6	NA	NA	NA	25
Overburden Dump Disturbance	50	180	-	NA	NA	NA	NA	230
Employee Access Roads	132	1.1	32	37	125	35	8.7	371
Haul Roads (coal)	158	105	31	437	NA	NA	NA	731
Haul Roads (overburden)	40	222	-	NA	NA	NA	NA	262
Haul Road Repair	56	56	56	56	NA	NA	NA	224
Dozers (overburden dumps)	56	81	56	224	NA	NA	NA	417
Wind Erosion	299	1,702	453	2,111	135	36	36	4,772
Total	1,021	3,166	1,596	4,751	406	204	78	11,223

NA means not available.

- Particular operation not active in 1985.

*Considered in the cumulative impact analysis.

1990 PARTICULATE EMISSIONS FROM COAL MINES IN ES REGION

(tons per year)

	North Block	Twin Creek	South Haystack	Black Butte	Long Canyon	Winton*	Reliance*	Total
Overburden Removal	133	648	763	960	NA	NA	NA	2,504
Ore Loading	70	125	150	315	100	100	25	885
Truck Dumping	14	25	30	63	20	20	5	177
Train Loading	NA	2.5	3.0	6.3	2	2	0.5	16.3
Conveying	7	12.5	15	31.5	10	10	2.5	88.5
Coal Storage	NA	0.7	0.8	1.7	13.5	0.5	0.1	17.3
Crushing (primary)	0.7	1.2	1.5	3.2	1.0	1.0	0.2	8.8
Crushing (secondary)	5.6	4	4.8	10.1	NA	NA	NA	21.2
Overburden Dump Disturbance	-	-	-	NA	NA	NA	NA	-
Employee Access Roads	132	1.1	32	37	125	34.8	8.7	370.9
Haul Roads (coal)	157.5	158	31	417	NA	NA	NA	763.5
Haul Roads (overburden)	-	-	-	NA	NA	NA	NA	-
Haul Road Repair	56	56	56	56	NA	NA	NA	224
Dozers (overburden dumps)	56	80.6	56	224	NA	NA	NA	416.6
Wind Erosion	298	1,434	550	1,861	135	36	36	4,350
Total	930	2,549	1,693	3,986	406	204	78	9,843

NA means not available.

- Particular operation not active in 1990.

*Considered in the cumulative impact analysis.

- Emissions from coal handling and storage account for only about 2% of the total fugitive emissions at the surface mines and 10 to 15% of the total for the underground mines.
- Because overburden removal and truck haulage is not involved in the underground mines, wind erosion, coal handling, and access roads are predicted to account for a significantly higher percentage of the total emissions at these mines compared with the surface mines. Fugitive emissions from underground mines, however, are typically an order of magnitude (or more) lower than surface mine emissions.

Where input data were not available, it was assumed that routine practices at existing surface and underground mines would be employed, except that recently enacted Wyoming regulations for dust control would be implemented as part of the proposed action.

In general, an attempt was made to take a conservative, albeit realistic, approach in the emissions analysis. Consequently, while it is not possible to guarantee that none of the results underestimate the actual situation, the likelihood of overprediction from the composite of all mining activities at a given mine should be higher than that of underprediction.

Aside from the relatively large error inherent in state-of-the-art emission prediction methodology, additional uncertainties arise depending on the ultimate adherence of each mine to its stated mode of operation, as well as its mining sequence and reclamation plans. For some of the mines, such plans were still in the formative stages when this analysis was conducted. Even in those cases where detailed plans had been formulated, future deviations are possible because of such factors as uncertainties in pre-operation geological surveying, labor strikes, the development of new mining technologies, a significant change in the projected markets for western coal, or new state or federal environmental regulations.

No attempt has been made in this investigation to evaluate the potential uncertainties inherent in the mining plans, although these uncertainties are recognized in those instances where the ultimate impact on annual emissions would be significant. Prediction methodology is, for the most part, not based on particulate sampling at prototype coal mines, but on empirical relationships developed for nonmining sources. Preliminary studies conducted at several western surface mines have indicated, in fact, that for some activities, such as aggregate storage or dragline removal of overburden, errors of an order of magnitude or more are possible.

Because of the serious limitations inherent in state-of-the-art emission factors, the fugitive emissions burdens estimated for proposed and projected coal mines in the southwest Wyoming ES region, along with

subsequently derived particulate concentrations, are deemed to be of little or no value in assessing absolute impact in terms of compliance with existing air quality standards. The quantitative results should, therefore, be viewed as merely a device to be used in a comparative assessment of impact among different coal mines, scenarios, or sub-regions and for clues as to the appropriate prioritization of mitigating measures.

Modeling Techniques

The ERT air quality model (ERTAQ) was used to model long-term impact of all emissions shown in Tables SC4-1, SC4-2, and SC4-3. A description of ERTAQ and its relation to diffusion modeling is discussed in the Chapter 4 Regional Technical Report.* The emissions from the various sources at each mine were added to represent a single source originating across the entire mining area. For analytical purposes, each mine was modeled as an area source. Because of the wide variations in individual emission point characteristics during mining operations, the size of each area source was equated to the area of disturbed acreage. For the calculation of annual average concentrations, disturbed acreage is defined as that portion of land where ongoing mining operations are active in combination with previously mined, unreclaimed acreage. Table SC4-4 depicts the disturbed acreage used in the annual average simulations for each mine. For 24-hour average calculations, it is assumed that disturbed acreage on any one day would not exceed 25 acres. This is a realistic representation considering the wide variations in individual emission points during mining operations. Therefore, the size of each area source for all mines associated with disturbed acreage greater than 25 for the annual average analysis was reduced for modeling 24-hour averages.

Impact on Air Quality. The impact on regional TSP concentrations was assessed for the years 1980, 1985, and 1990. The ERTAQ model was employed to calculate ground-level concentrations of suspended particulates (SP) attributable to the mines alone for annual and 24-hour averaging periods. Meteorological specifications for input to the model were derived from five years of observations taken at Rock Springs and Fort Bridger. The Rock Springs data were employed for the Long Canyon, and Black Butte study areas. The Fort Bridger data were used for South Haystack, Twin Creek, and North Block study areas. A stability wind rose was employed to calculate annual average concentrations at 128 receptor locations. The concentrations calculated for each receptor represent the weighted annual average for 480 possible weather conditions (sixteen wind directions times six wind speed categories times five stability classes). These concentrations were then compared to the annual Prevention of Significant Deterioration (PSD) increments.

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*Located in the BLM Rock Springs District Office.

TABLE SC4-4

ACRES DISTURBED EQUALS SIZE OF AREA SOURCE IN ERTAQ MODELING

	1980	1985	1990
Long Canyon	542	542	542
Black Butte	1,399	3,303	2,996
North Block	216	316	311
South Haystack	743	566	671
Twin Creek	643	1,536	1,423
Winton*		140	140
Reliance*		90	90

*Considered in the cumulative impact analysis.

The 24-hour standards, which are written not to be exceeded more than once per year, suggest worst-case analyses to estimate whether or not concentrations exceeding these standards would occur. Worst-case 24-hour conditions are defined as the combination of poor atmospheric dispersion conditions and wind direction persistence leading to maximum 24-hour impact. These factors were derived from the Rock Springs and Fort Bridger data. Tables SC4-5 and SC4-6 list the worst-case 24-hour meteorological conditions applicable to the region. They were specified in the ERTAQ model for calculations of worst-case 24-hour impact. The impact at each of the 128 receptors was calculated for each wind direction and corresponding conditions of stability, persistence, and wind speed. In this manner, the worst-case impact at each receptor due to emissions from the proposed actions was determined. A detailed discussion of the derivation of these worst-case conditions is presented in the Regional Technical Report.

Uncertainties Associated with Modeling Fugitive Dust Emissions

Prior to evaluating the numerical results of this analysis, it is essential to denote the uncertainties associated with the modeling of fugitive dust from coal mines. Although the ERTAQ model and its application herein is considered state-of-the-art technology, inherent assumptions need to be stressed.

Meteorological Data. As previously discussed, because of the lack of on-site data, meteorological specifications for model input were derived from five years of observations taken at Rock Springs and Fort Bridger. The distance between these meteorological stations and the corresponding mines ranges from 12 to 36 miles. It is unlikely that the same conditions (wind speed, wind direction, and stability) recorded at the meteorological stations would have been concurrently observed at the mine sites. The differences in meteorology experienced by the two locations can occur on three scales: (1) microscale effects of topography on local wind speed and mechanical turbulence and the effect of local vegetative cover on surface heating and, hence, the thermal turbulence (i.e., stability); (2) the mesocale differences, such as local cloud cover, thunderstorm activity, squall lines etc., that can cause differences in stability, wind speed, and wind direction; and (3) synoptic scale effects of cyclonic weather systems on wind direction. Therefore, the degree to which the Rock Springs and Fort Bridger data are representative of the meteorology at the mine locations is unknown.

Emission Rates. In addition to the limitations pertaining to the reliability of emission factor derivation, the model simulations assume the effluent rate to be constant to represent steady-state conditions. That is, the emission rates depicted in Tables SC4-1, SC4-2, and SC4-3 are assumed to characterize fugitive dust emissions from the mine for annual as well as 24-hour average model calculations. Such an assumption

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TABLE SC4-5

WORST-CASE 24-HOUR METEOROLOGICAL CONDITIONS FOR IMPACT OF GROUND-LEVEL SOURCES AT ROCK SPRINGS

Wind Direction	Atmospheric Stability			
	Stable		Neutral	
	Persistence (hours)	Wind Speed (mph)	Persistence (hours)	Wind Speed (mph)
N	4	4	-	-
NNE	4	4	-	-
NE	-	-	24	10
ENE	-	-	16	10
E	7	4	-	-
ESE	6	4	-	-
SE	9	6	-	-
SSE	6	6	-	-
S	13	4	-	-
SSW	5	4	-	-
SW	-	-	24	10
WSW	12	4	8	4
W	8	4	-	-
WNW	-	-	15	10
NW	8	6	-	-
NNW	3	4	-	-

TABLE SC4-6

WORST-CASE 24-HOUR METEOROLOGICAL CONDITIONS FOR IMPACT OF GROUND-LEVEL SOURCES AT FORT BRIDGER

Wind Direction	Atmospheric Stability			
	Stable		Neutral	
	Persistence (hours)	Wind Speed (mph)	Persistence (hours)	Wind Speed (mph)
N	6	4	-	-
NNE	4	6	-	-
NE	6	6	-	-
ENE	12	4	1	4
E	11	6	-	-
ESE	12	6	1	6
SE	7	4	-	-
SSE	3	4	-	-
S	6	6	-	-
SSW	-	-	9	10
SW	-	-	15	10
WSW	12	6	2	6
W	14	6	1	6
WNW	12	4	1	4
NW	12	4	1	4
NNW	4	6	-	-

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indicates that the mining operations considered are continuous without variation. The actual worst-case impact of emissions from the mine during any hour is a function of the joint occurrence of specific dust-producing activities and local worst-case meteorology. Since activity at any one mine is bound to fluctuate daily or even hourly, a degree of uncertainty is inherent in the model simulations.

Source-Receptor Geometry. In this study, the mines were modeled as area sources; the size of each area source was equated to the disturbed acreage calculated for each analysis year. Therefore, emission rates incorporating all types of mining activities were uniformly distributed across a single area source. This neglects the actual variation in specific source locations and dimensions (such as haul roads, shoveling, and dragline activities) that are actually a combination of line, point, and smaller area sources, not withstanding the actual exposed acreage vulnerable to wind erosion. The effect of a more realistic source geometry characterization would be most noticeable at sensitive receptors located near the mine sites where the highest concentrations are predicted to occur. Hence, another degree of uncertainty is introduced into the model calculations due to the lack of detailed source-receptor geometries.

Topography. Because of time constraints, lack of data, and model limitations, the effect of topography on local diffusion characteristics was not considered in this analysis. That is, the whole ES region, approximately 180 miles by 150 miles, was assumed to be flat. As discussed in Chapter 2, the ES region is contained within a broad mountain basin interspersed with much irregular terrain. The extent to which such terrain would affect the dispersion of fugitive dust emissions from the coal mines is unknown.

Deposition. Deposition, although somewhat inherent in the derivation of emission factors, is not included in the ERTAQ model due to lack of source specific information on particle characteristics. If deposition was included in the modeling of fugitive emissions, concentrations predicted during light wind speed conditions could be reduced substantially. The effect of deposition at higher wind speeds is much less because the wind energy is able to carry large particles further. However, at the present time, theoretical equations characterizing deposition of fugitive dust from coal mines have not been adequately validated. Therefore, the degree of accuracy associated with simulated SP concentrations on the scale of this regional application is questionable.

Initial Mixing Volume. For nonbuoyant fugitive dusts from ground-level area sources, zero plume rise is assumed. Emissions actually occur at various elevations and are subject to the effect of the variation in actual mine site topography and surface heating characteristics on thermally and mechanically induced turbulence. To simulate this

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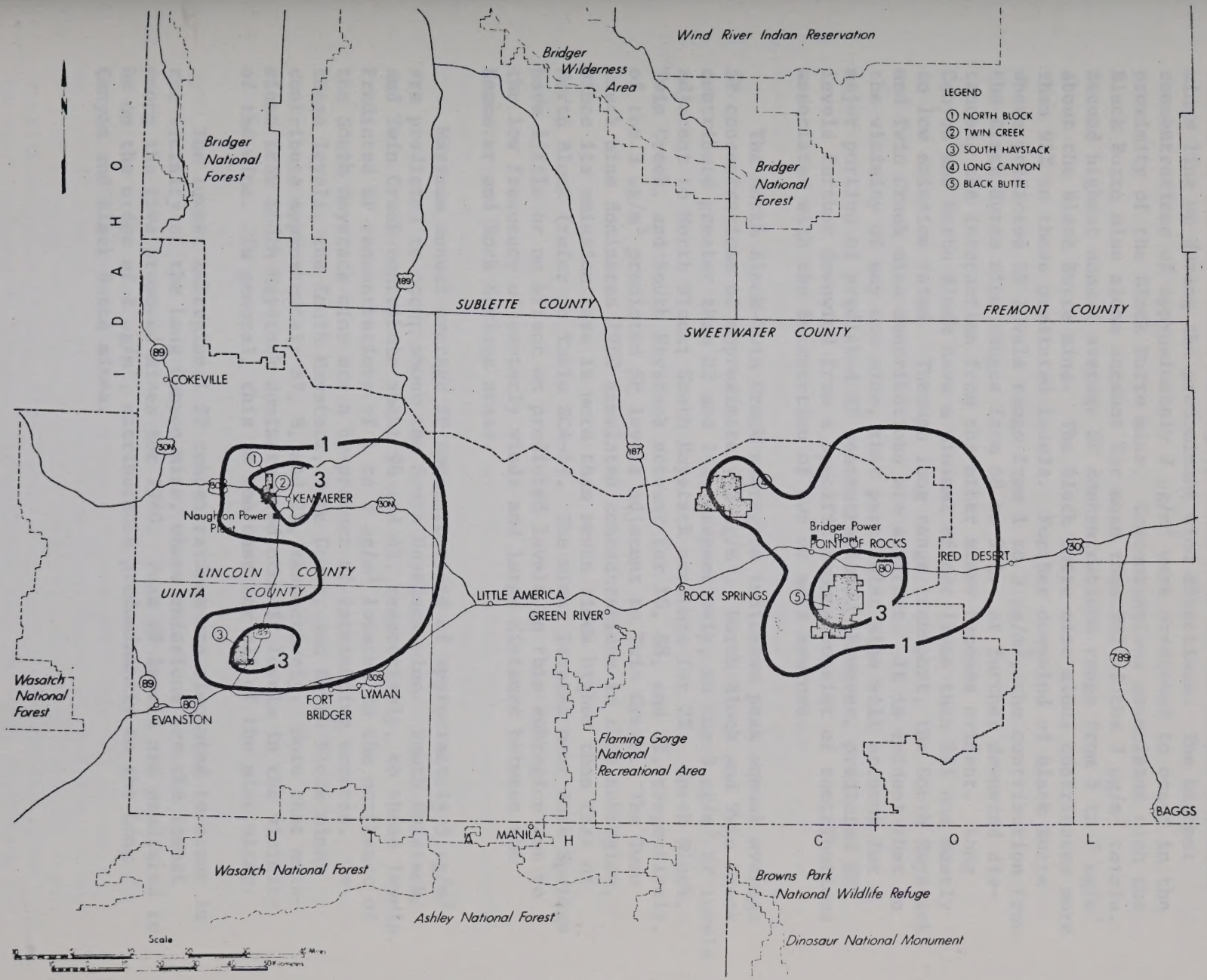
effect, an initial mixing volume of 30 feet for area sources of mine operations is assumed. This feature allows the pollutant to form "puffs" of the specified depth before dispersing downwind. Without monitoring data for use in verification, the accuracy of such an assumption is unknown.

The purpose of this section exhibiting the uncertainties associated with the modeling of fugitive dusts is to prepare the reader for proper evaluation of the impact results presented in the following sections. When evaluating isopleths depicting annual and 24-hour average impact resulting from the most probable level of mining development, the reader must realize that the absolute value of the numbers associated with the impacts were derived from analysis techniques involving a large number of uncertainties. The important points to note are the relative contributions from the individual mines to simulated SP concentrations, as well as the relative distribution of predicted SP levels indicative of the interaction of the individual mines with one another under specific meteorological conditions. In this sense, if all the aforementioned uncertainties have the same effect on each mine, the absolute values associated with the isopleths presented in the next section would change, but the predicted distribution and the contribution from each mine to simulated SP levels would not. In this manner, as the state-of-the-art technology for evaluating fugitive dust emissions improves, the value of this analysis as a guideline to evaluate relative impact from the most probable level of mining development will not change.

Model Predictions of Annual Average Impact on SP Concentrations for 1980

Map SC4-1 depicts the incremental increase from the proposed actions to annual average SP concentrations in 1980. The subregional concentrations presented in the text are also attributable to the five proposed mines alone. (Subregional isopleth maps are presented in the Chapter 4 Regional Technical Report). The model results, therefore, represent the proportional contribution of mining activity to the levels specified in the national and state ambient air quality standards. An evaluation of the total ambient levels of TSP is presented in the "Cumulative Air Quality Impacts" section of this report. Total ambient levels refers to proposed action impact plus other mining activities (Winton and Reliance) plus background (i.e., impact resulting from sources other than those being modeled). The model predictions presented below are evaluated for PSD regulations, since these apply to source specific impact alone.

Regionally, predicted annual average SP concentrations from the mining activities range from 1 to 7 $\mu g/m^3$. Note that the highest concentrations occur close to the actual mine sites, and that the isopleths depicting such levels are skewed to the east and northeast. This type of distribution is attributable to the predominant frequency of west and southwest winds as recorded at the Fort Bridger and Rock Springs meteorological stations. Interaction between mines lining up is not a major



Map SC4-1

1980 Predicted Annual Average SP Concentrations ($\mu g/m^3$)
Attributable to the Proposed Action Mines Alone

consideration for annual averages, since none of the proposed action mines line up during the predominant wind directions. The highest concentrations of approximately 7 $\mu g/m^3$ were predicted to occur in the proximity of the Black Butte mine. Concentrations associated with the Black Butte mine alone account for more than 96% of the 7 $\mu g/m^3$ totals. Second highest annual average SP concentrations range from 5 to 7 $\mu g/m^3$ about the Black Butte mine. The Black Butte mine alone contributes more than 92% to these predicted levels. Further downwind of Black Butte where predicted SP levels range from 1 to 3 $\mu g/m^3$, the contribution from the Black Butte mine ranges from 68 to 90%. At further downwind distances, the interaction from the other mines becomes evident. Long Canyon and North Block have a minimal effect (less than 2%) due mostly to low emission rates. Through long range transport, the South Haystack and Twin Creek mine contributions are apparent. It is evident that in the vicinity of any one mine, that particular mine will account for a major portion of predicted SP concentrations. However, predicted SP levels further downwind from a specific source consist of contributions associated with the interaction of two or more sources.

The North Block-Twin Creek subregion indicates peak annual average SP concentrations of approximately 3 $\mu g/m^3$. North Block and Twin Creek contribute greater than 22 and 74%, respectively, to the 3 $\mu g/m^3$ SP levels adjacent to North Block; South Haystack accounts for 2%. North Block, Twin Creek, and South Haystack account for 10, 88, and 2%, respectively, of the 3 $\mu g/m^3$ predicted SP levels adjacent to Twin Creek. The Twin Creek mine dominates 1980 simulated concentrations in this subregion, since its emission rate is more than seven times higher than that of North Block (refer to Table SC4-1). The mines located near Rock Springs have little or no effect on predicted levels in this subregion due to the low frequency of easterly winds and large distance between the Kemmerer and Rock Springs areas.

Maximum annual average SP concentrations of approximately 5 $\mu g/m^3$ are predicted to occur about the South Haystack mine. South Haystack and Twin Creek contribute about 96 and 4%, respectively, to these levels. Predicted SP concentrations of 1 to 3 $\mu g/m^3$ located to the northeast of the South Haystack mine are a by-product of interacting sources. To these levels, the South Haystack, Twin Creek, and North Block mines contribute approximately 87, 8, and 2%, respectively. Note that emissions from South Haystack dominate predicted SP levels in the vicinity of the mine. In general, this is the case for all of the mine sites.

The lowest subregional SP concentrations are simulated to occur in the vicinity of the Long Canyon mine, whose emissions are the lowest among the five proposed mines for 1980. Peak SP levels are predicted to be on the order of 1 $\mu g/m^3$, attributable predominantly to the Long Canyon and Black Butte mines.

In accordance with the Clean Air Act Amendments of 1977 and associated PSD regulations, the entire segment of southwest Wyoming is classified as a Class II area. The only exception is the Bridger Wilderness Area (see Map SC4-1), which is a Class I area. Allowable PSD increments are depicted in Table SC4-7. Predicted SP levels in this area are less than 1 $\mu g/m^3$, which is below the Class I 5 $\mu g/m^3$ increment. Predicted SP levels elsewhere peak at 7 $\mu g/m^3$ in the vicinity of the Black Butte mine. Since the annual Class II increment is 19 $\mu g/m^3$, the predicted impact from the most probable level of mining development is well within PSD regulations for 1980.

The Flaming Gorge Recreational Area shown on Map SC4-1 and the Fossil Butte National Monument (located approximately 10 miles northwest of Kemmerer) are presently Class II regions but eligible for reclassification to Class I. However, the predicted impact for both areas is less than 1 $\mu g/m^3$, which is below both the Class I and II PSD increments.

The State of Wyoming and the EPA have designated the trona patch, 6 miles north of Green River, as a nonattainment (NA) area. This indicates that ambient TSP levels measured in the trona patch exceeded the NAAQS at the time of NA designation. As shown in Map SC4-1, annual average SP concentrations less than 1 $\mu g/m^3$ are predicted to occur in this NA area in 1980. The predicted proposed actions impact is approximately 1% of the 75 $\mu g/m^3$ federal standard.

Model Predictions of Annual Average Impact on SP Concentrations for 1985 and 1990

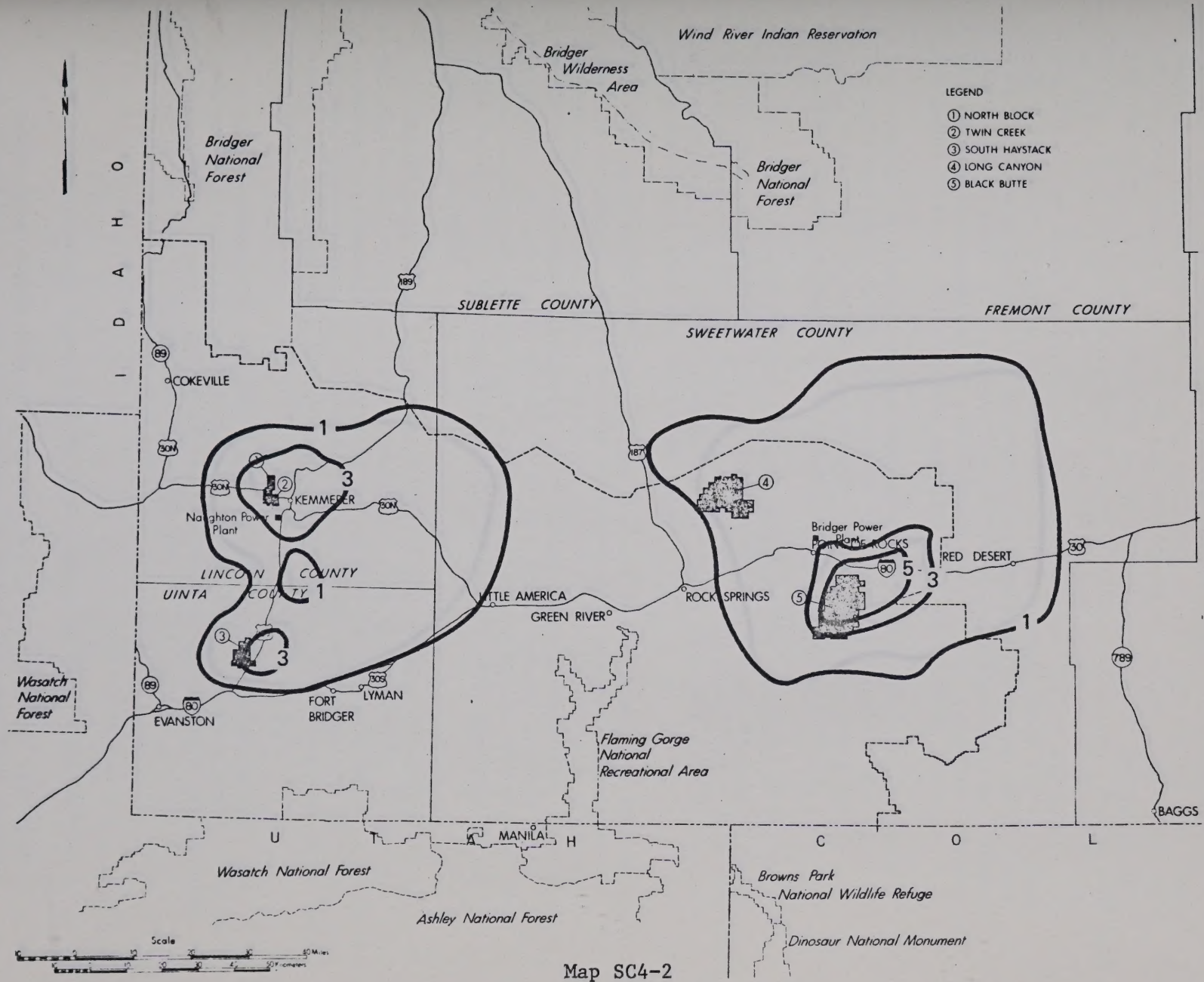
Except for Black Butte and Twin Creek, particulate emission rates for each proposed mine vary insignificantly from 1985 to 1990; therefore, Maps SC4-2 and SC4-3 depicting SP impacts for both analysis years are very similar. Consequently, a discussion of the model predictions for annual average SP concentrations applies to both years.

Regionally, predicted SP levels attributable to the mining operations vary from 1 to 11 $\mu g/m^3$ in 1985 and 1 to 9 $\mu g/m^3$ in 1990. Since combined emission rates emanating from the proposed actions are higher in 1985 than 1990, predicted impacts are higher. As shown in the results for 1980, the highest concentrations occur close to the actual mine sites, and the isopleths depicting such levels are skewed to the east and northeast attributable to the predominant frequency of west and southwesterly winds. The highest concentrations of approximately 11 $\mu g/m^3$ in 1985 and 9 $\mu g/m^3$ in 1990 are predicted to occur in the vicinity of the Black Butte mine. Concentrations resulting from emissions at the Black Butte mine alone comprise more than 96% of these maximum SP levels. Contributions from Black Butte to predicted levels of 3 to 11 $\mu g/m^3$ in 1985 and 3 to 9 $\mu g/m^3$ in 1990 range from 85 to 97% for both analysis years. Black Butte's highest contributions occur in the near vicinity of the mine and decrease with distance away from the mine.

TABLE SC4-7

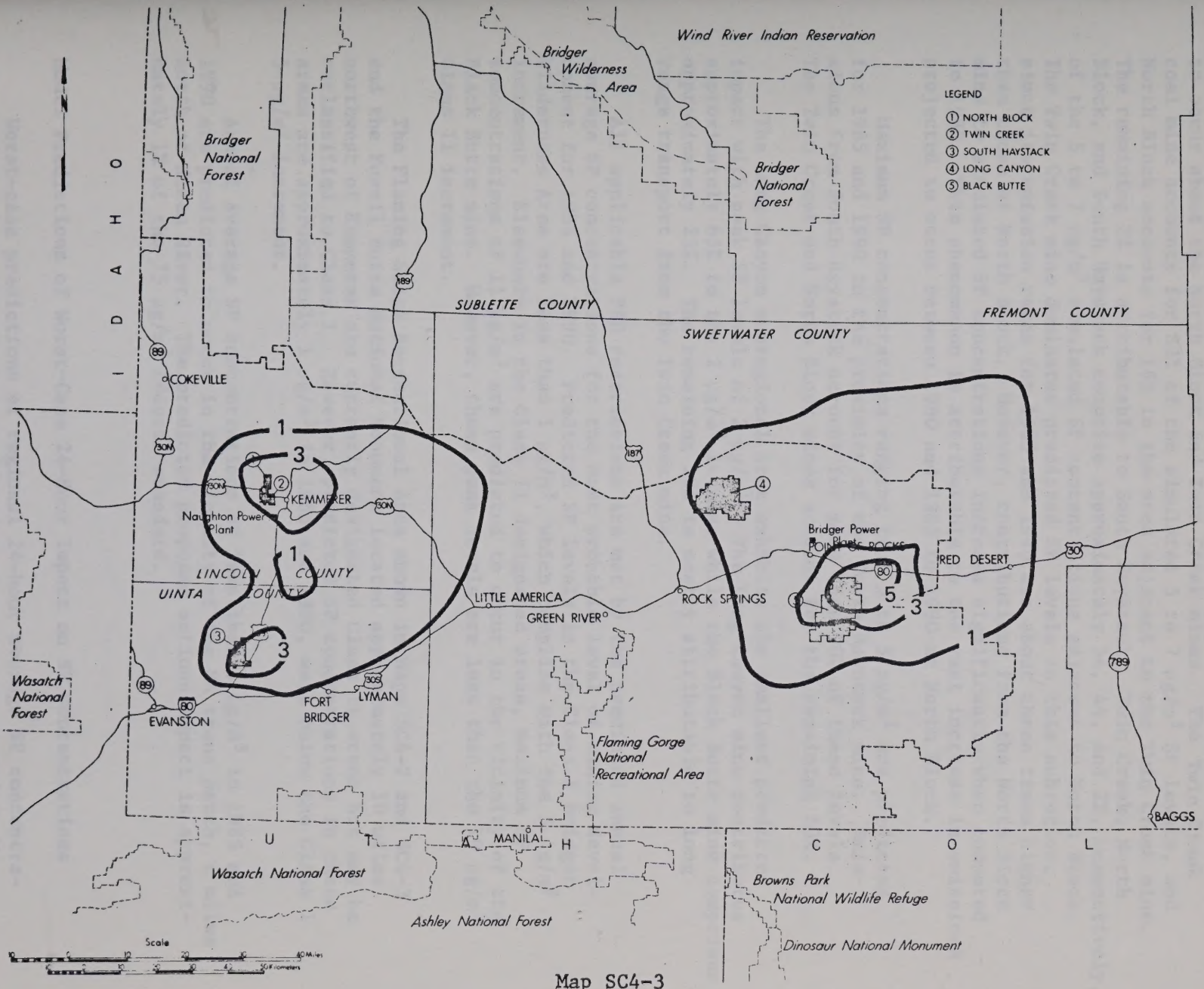
ALLOWABLE AIR QUALITY INCREMENTS UNDER SIGNIFICANT DETERIORATION RESTRICTIONS ($\mu g/m^3$)

EPA Pollutant Standard		Class I	Class II	Class III
TSP				
	Annual	5	19	37
	24-hour	10	37	75



Map SC4-2

1985 Predicted Annual Average SP Concentrations ($\mu g/m^3$)
Attributable to the Proposed Action Mines Alone



Map SC4-3

1990 Predicted Annual Average SP Concentrations ($\mu g/m^3$)
Attributable to the Proposed Action Mines Alone

The second highest subregional concentrations of 7 $\mu g/m^3$ are predicted to occur about the North Block and Twin Creek mines. The Twin Creek coal mine accounts for 82% of the simulated 5 to 7 $\mu g/m^3$ SP levels, and North Block accounts for 16% in the area adjacent to the Twin Creek mine. The remaining 2% is attributable to South Haystack. Twin Creek, North Block, and South Haystack comprise approximately 54, 44, and 2%, respectively, of the 5 to 7 $\mu g/m^3$ simulated SP concentrations adjacent to North Block. The Twin Creek mine dominates predicted SP levels in this subregion, since its emission rates for 1985 and 1990 are about three times higher than those of North Block. However, contributions from the North Block mine to simulated SP concentrations increase significantly when compared to 1980. This phenomenon is attributable to the vast increase in emissions projected to occur between 1980 and 1985 to 1990 at North Block.

Maximum SP concentrations ranging from 3 to 5 $\mu g/m^3$ are predicted for 1985 and 1990 in the proximity of the South Haystack mine. Emissions from South Haystack account for more than 90% of these levels. The Twin Creek and North Block mines account for the remaining 10%.

The Long Canyon subregional area exhibits the smallest predicted impact with peak SP levels of 2 $\mu g/m^3$. The Long Canyon mine contributes approximately 65% to the 2 $\mu g/m^3$ levels; while the Black Butte mine comprises approximately 23%. The remaining 12% is mostly attributable to long range transport from the Twin Creek mine.

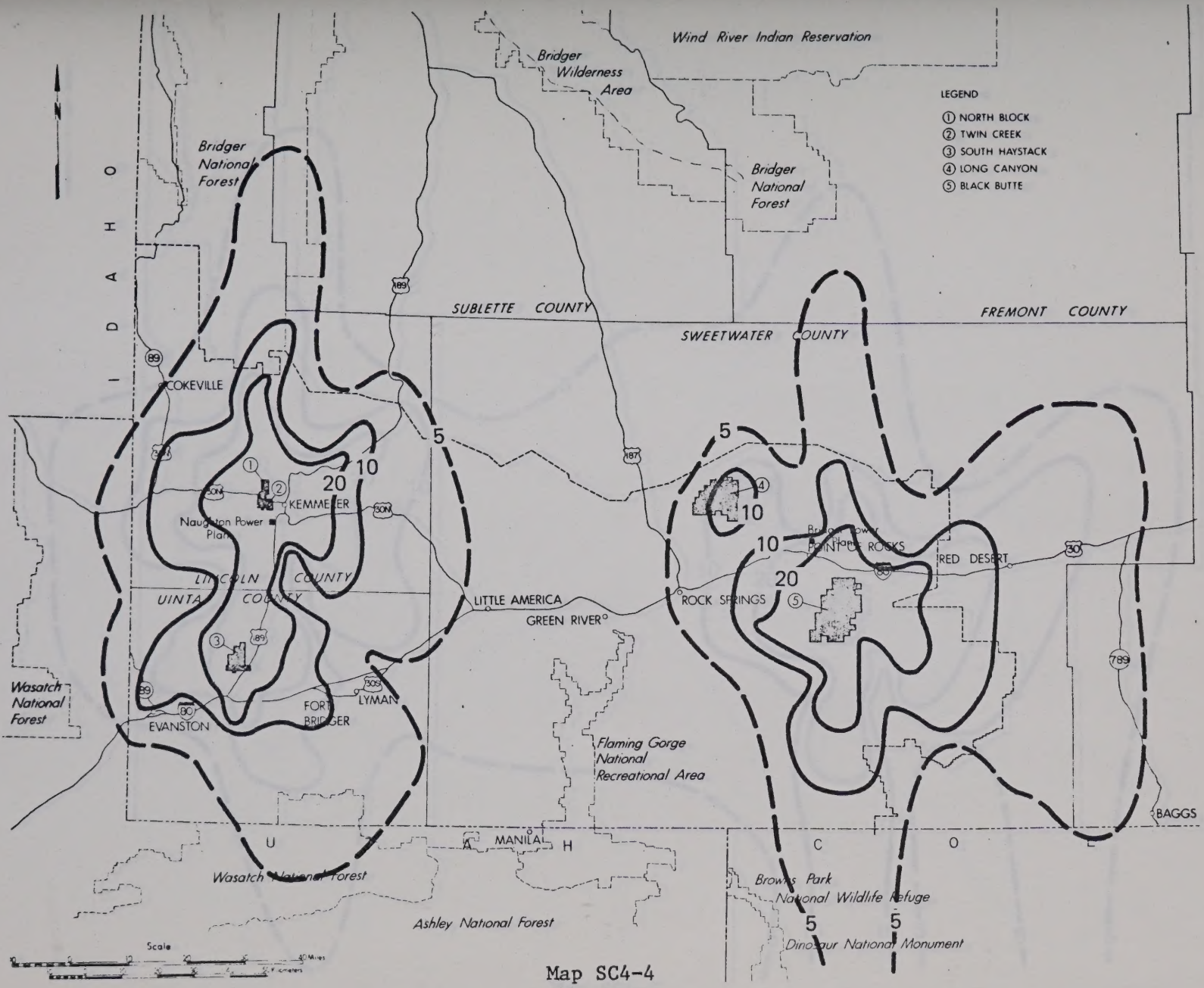
All applicable PSD restrictions are met by the predicted annual average SP concentrations for the most probable level of mining development for 1985 and 1990. Predicted SP levels in the Class I Bridger Wilderness Area are less than 1 $\mu g/m^3$, which complies with the 5 $\mu g/m^3$ increment. Elsewhere in the Class II designated areas, maximum SP concentrations of 11 $\mu g/m^3$ are predicted to occur in the vicinity of the Black Butte mine. However, these peak levels are less than the 19 $\mu g/m^3$ Class II increment.

The Flaming Gorge Recreational Area shown in Maps SC4-2 and SC4-3 and the Fossil Butte National Monument located approximately 10 miles northwest of Kemmerer are currently designated Class II areas but may be reclassified to Class I. However, predicted SP concentrations in these areas are approximately 1 $\mu g/m^3$ in 1985 and 1990, well below the Class I 5 $\mu g/m^3$ increment.

Annual average SP concentrations of less than 1 $\mu g/m^3$ in 1985 and 1990 are predicted to occur in the vicinity of the NA trona patch, 6 miles north of Green River. The predicted proposed actions impact is approximately 1% of the 75 $\mu g/m^3$ federal standard.

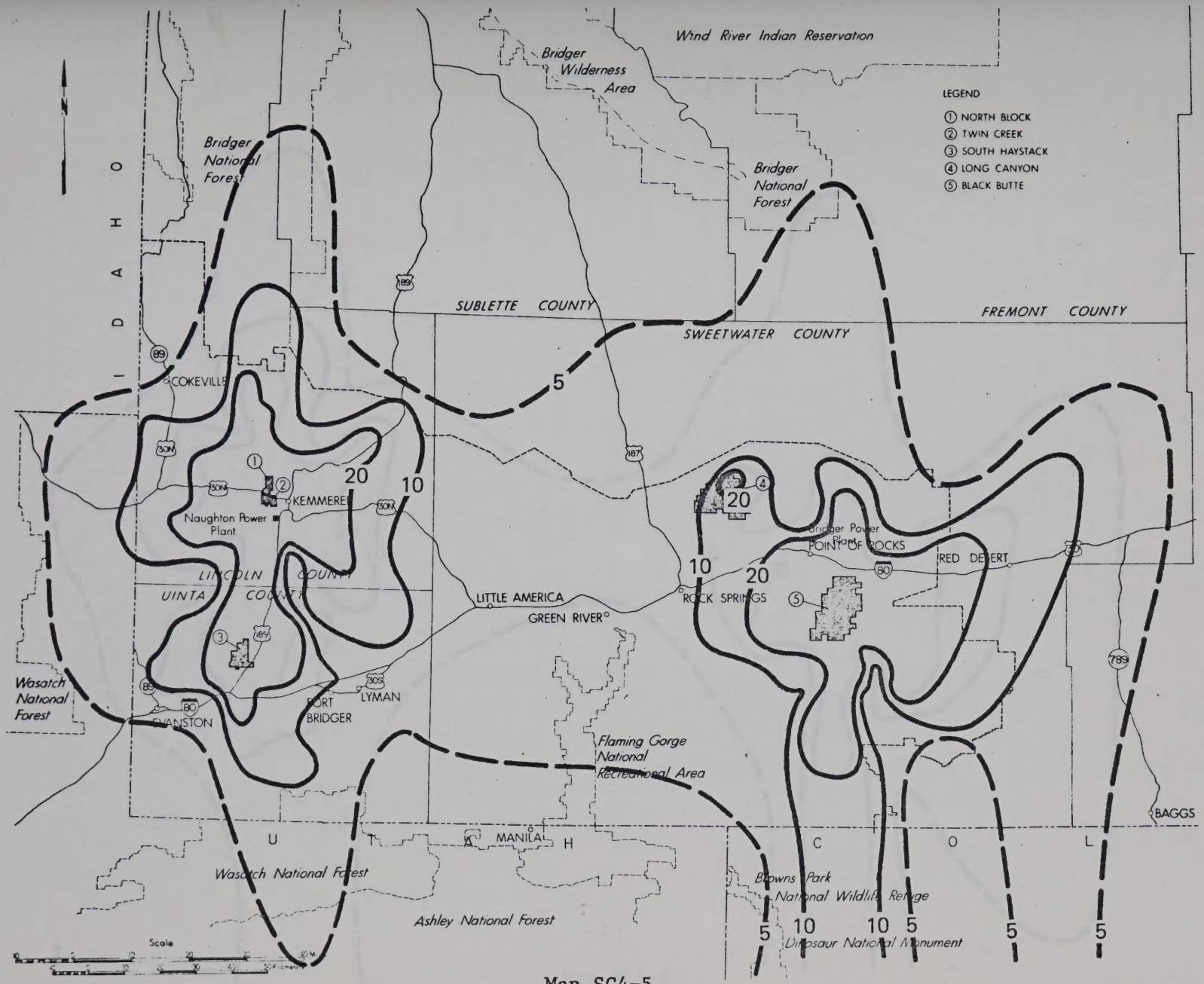
Model Predictions of Worst-Case 24-Hour Impact on SP Concentrations

Worst-case predictions of regional 24-hour average SP concentrations associated with the proposed action mines are presented in Maps SC4-4 through SC4-6. The meteorology used to simulate these concentrations



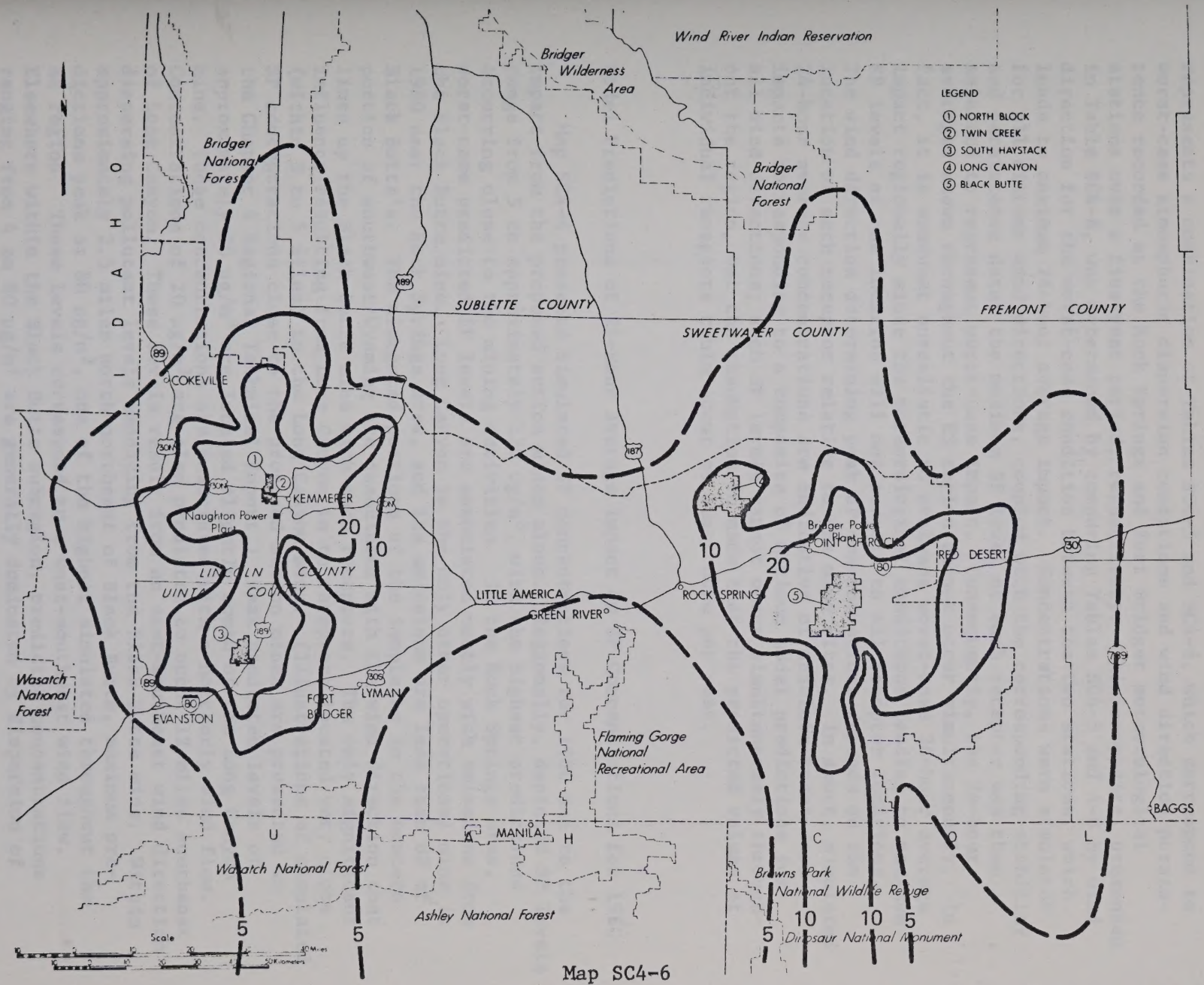
Map SC4-4

1980 Predicted 24-Hour Average SP Concentrations ($\mu g/m^3$)
Attributable to the Proposed Action Mines Alone



Map SC4-5

1985 Predicted 24-Hour Average SP Concentrations ($\mu g/m^3$)
Attributable to the Proposed Action Mines Alone



Map SC4-6

1990 Predicted 24-Hour Average SP Concentrations ($\mu g/m^3$)
Attributable to the Proposed Action Mines Alone

represents a combination of Tables SC4-5 and SC4-6, which correspond to worst-case atmospheric dispersion conditions and wind direction persistence recorded at the Rock Springs and Fort Bridger meteorological stations over a five-year period, respectively. This composite, presented in Table SC4-8, was determined by comparing Tables SC4-5 and 4-6 by wind direction for the worst-case condition between the two stations, which leads to maximum 24-hour average impact. Concentrations were simulated for all sixteen wind directions, coupled with the corresponding stability and persistence data; the maximum SP level at each receptor was then selected to represent worst-case impact. Consequently, the 24-hour averages shown throughout the ES region cannot occur simultaneously. In fact, it is somewhat unrealistic to evaluate worst-case 24-hour average impact regionally since the meteorological conditions leading to maximum SP levels at one location will not pertain to all receptor locations. The wind direction determining peak SP concentrations depends on the location of each receptor relative to the mine sites. In short, simulated 24-hour average concentrations are indicative of absolute worst-case impacts corresponding to a composite of maximum model predictions for all wind directions; such SP levels cannot occur simultaneously throughout the region, but the assumption is made that the predicted values at individual receptors could occur at least once per year.

Model Predictions of 24-Hour Average Impact on SP Concentrations for 1980

Map SC4-4 presents simulated SP concentrations for 1980 due to the impact from the proposed action mines alone. Regionally, depicted SP levels range from 5 to approximately 120 $\mu g/m^3$, with the highest predictions occurring close to the mining activities. In the Rock Springs area, worst-case predicted SP levels are associated mostly with emissions from the Black Butte mine. Long Canyon is the only other operational mine in 1980 near the Rock Springs area, and its emissions are less than 8% of Black Butte's. The elongated portions of the isopleths in the eastern portion of southwest Wyoming are associated with the wind direction that lines up the Black Butte mine with such receptors. The only significant influence resulting from Long Canyon is to receptors located very close (within 3 to 5 miles) to the Long Canyon mine. (Illustrations of simulated SP concentrations close to the proposed action mines are presented in the Chapter 4 Regional Technical Report.) Peak predicted levels of approximately 20 $\mu g/m^3$ are located slightly south of the Long Canyon mine. These concentrations are associated with a northerly wind flow. Concentrations of 20 $\mu g/m^3$ are also predicted to occur 12 miles southeast of Long Canyon. These levels result from an east-southeast wind direction dispersing pollutant levels emanating from the Black Butte mine. Within approximately 2.5 miles north-northeast of Black Butte, maximum predictions peak at 80 $\mu g/m^3$, one of the highest simulated throughout the ES region. These levels correspond to a west-southwest wind flow. Elsewhere within the Black Butte subregion, predicted concentrations ranging from 4 to 80 $\mu g/m^3$ are generally dominated by dispersion of Black Butte's emissions.

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TABLE SC4-8

COMPOSITE* METEOROLOGICAL CONDITIONS FOR WORST-CASE
24-HOUR AVERAGE IMPACT ON TSP CONCENTRATIONS

Wind Direction	Atmospheric Stability			
	Stable		Neutral	
	Persistence (hours)	Wind Speed (mph)	Persistence (hours)	Wind Speed (mph)
N	6	4	-	-
NNE	4	4	-	-
NE	-	-	24	10
ENE	12	4	1	4
E	11	6	-	-
ESE	12	6	1	6
SE	7	4	-	-
SSE	6	6	-	-
S	13	4	-	-
SSW	5	4	-	-
SW	-	-	24	10
WSW	12	4	8	4
W	14	6	1	6
WNW	12	4	1	4
NW	12	4	4	4
NNW	3	4	-	-

*Determined from Rock Springs and Fort Bridger data.

In the western half of the ES region, Map SC4-4 indicates significant impact resulting from north and south wind flow. Because of the relative locations of North Block, Twin Creek, and South Haystack, both northerly and southerly winds result in the interaction of pollutants dispersing from all three surface mines. Such interaction is seen to effect simulated SP concentrations approximately 60 miles north and south of Kemmerer. Interaction between the South Haystack mine and the North Block-Twin Creek mining subregion is small or nonexistent under easterly or westerly wind flow. In general, predicted levels east or west of South Haystack (within about 40 miles) are dominated by fugitive dust emissions dispersing from the South Haystack mine. Similarly, predicted levels within approximately 50 miles east or west of North Block and Twin Creek are mainly a function of emissions emanating from these two mines. However, in 1980 emissions from the Twin Creek mine are seven times higher than estimated emissions from North Block; therefore, Twin Creek has greater influence in this subregion. Maximum predicted SP concentrations in the North Block-Twin Creek subregion are on the order of 120 $\mu g/m^3$, although the peak predicted concentration within 2 miles south of Twin Creek is 227 $\mu g/m^3$. Because of its high emission rates (see Table SC4-1), the Twin Creek mine dominates predicted concentrations in this subregion.

Predicted SP levels about the South Haystack mine range from 20 to 80 $\mu g/m^3$. Again, interaction between mines is apparent with north and south wind directions. However, within approximately 3 miles of the mine, the major portion of simulated concentrations are attributable to South Haystack. This is the case in all subregions; the interactive effect between mines is not significant at receptors located close to the mine site.

Concentrations of SP predicted to occur throughout the Class I Bridger Wilderness Area are on the order of 1 $\mu g/m^3$, well below the 10 $\mu g/m^3$ allowable PSD increment. The allowable PSD increment for the rest of southwest Wyoming (designated Class II) is maintained regionally except in the vicinity of the surface mines. Except for the Long Canyon subregion, predicted SP levels within approximately 6 miles of the mine sites exceed the 37 $\mu g/m^3$ increment.

The Flaming Gorge Recreational Area shown on Map SC4-4 and the Fossil Butte National Monument (located approximately 10 miles northwest of Kemmerer) are currently Class II regions but may be redesignated to Class I. Concentrations of SP less than 4 $\mu g/m^3$ are predicted to occur throughout the Flaming Gorge Area, which complies with the Class I 10 $\mu g/m^3$ increment. Predicted levels at Fossil Butte are approximately 20 $\mu g/m^3$, which complies with the Class II increment but exceeds the allowable Class I increment.

Impact from the most probable level of mining development is indicated for the NA trona patch, 6 miles north of Green River. As indicated in Map SC4-4, predicted concentrations in this area are on the order of 4 $\mu g/m^3$, which is approximately 2% of the 260 $\mu g/m^3$ federal standard.

Model Predictions of 24-Hour Average Impact on SP Concentrations for 1985

Predicted SP impact from the proposed action mines alone is depicted in Map SC4-5. Regionally, simulated SP levels range from 5 to 120 $\mu g/m^3$, although somewhat higher concentrations are predicted to occur close to the North Block and Twin Creek mines. In the eastern portion of the ES region, estimated emissions emanating from the Black Butte mine dominate predicted impact. Long Canyon's estimated emission rate is less than 9% of the Black Butte mine emission rate. Therefore, the skewing effect illustrated by the isopleths is associated, in general, with the wind direction that lines up the Black Butte mine with a given receptor. The Long Canyon mine does influence concentrations predicted very close (within 3 to 5 miles) to the mine, but its contribution elsewhere is insignificant. The predicted concentrations in the Long Canyon subregion are low, with maximum levels of approximately 20 $\mu g/m^3$. Predicted levels of 20 to 40 $\mu g/m^3$ southeast of Long Canyon are attributable to an east-southeast wind direction dispersing emissions from the Black Butte mine. The 20 $\mu g/m^3$ levels predicted about the Long Canyon mine are mostly resultant from Long Canyon emissions. Peak levels of approximately 120 $\mu g/m^3$ are predicted to occur to the north-northeast of the Black Butte mine. Such concentrations are associated with a south-southwest wind direction. Elsewhere within the Black Butte subregion, concentrations are generally determined from the dispersion of estimated emissions from the Black Butte mine alone.

Similar to the 1980 analysis, Map SC4-5 depicts significant impact resulting from north and south wind flow in the western portion of the ES region. Due to the relative locations of North Block, Twin Creek, and South Haystack, both northerly and southerly winds result in the interaction of pollutants dispersing from all three surface mines. Such interaction is seen to affect simulated SP concentrations approximately 60 miles north and south of Kemmerer. Interaction between the South Haystack mine and the North Block-Twin Creek mining subregion is small or nonexistent under easterly or westerly wind flow. In general, predicted levels east or west of South Haystack (within about 40 miles) are a result of fugitive dust emissions dispersing from the South Haystack mine. Similarly, predicted levels within about 50 miles east or west of North Block and Twin Creek are a function of emissions emanating from these two mines. However, in 1985, emissions from the Twin Creek mine are three times higher than estimated emissions from North Block; therefore, Twin Creek has greater influence in this subregion. Predicted concentrations in the North Block-Twin Creek subregion are higher than anywhere else in the ES region. The maximum predicted concentration of 322 $\mu g/m^3$ is predicted to occur less than 2 miles south of Twin Creek and North Block, resulting in high impact from northerly wind flow. Elsewhere within the subregion, predicted levels range from approximately 20 to 120 $\mu g/m^3$.

Peak simulated levels of approximately 80 $\mu g/m^3$ occur in a small region south of the South Haystack mine. (Note that emissions from the mine are projected to decrease in 1985.) Such levels, for the most part, are attributable to emissions emanating from South Haystack

influenced by a north wind. The contribution from the North Block and Twin Creek mines is minimal so close to South Haystack. However, the interaction phenomenon induced by north wind flow is evident further downwind. Elsewhere, the South Haystack mine is the sole source of predicted levels within about 40 miles east or west of the mine site.

For PSD increments, simulated concentrations in the Bridger Wilderness Area are less than 2 $\mu g/m^3$, which does not interfere with the 10 $\mu g/m^3$ Class I increment. The remaining portion of southwest Wyoming is designated Class II; except for Long Canyon, simulated concentrations above the 37 $\mu g/m^3$ allowable PSD increment are predicted to occur as far out as 12 miles from some of the mine sites.

Presently, both the Flaming Gorge National Recreation Area and Fossil Butte National Monument are Class II regions, but they may be redesignated to Class I. Predicted worst-case 24-hour average concentrations at Flaming Gorge are approximately 5 $\mu g/m^3$, or less than the 10 $\mu g/m^3$ Class I increment. However, at the Fossil Butte National Monument, simulated SP levels are on the order of 20 $\mu g/m^3$, which exceeds the Class I increment but does not exceed the allowable Class II increment of 37 $\mu g/m^3$.

The trona patch, 6 miles north of Green River, is designated an NA area. Simulated SP impact for this area is approximately 7 $\mu g/m^3$, which is approximately 3% of the federal 260 $\mu g/m^3$ standard.

Model Predictions of 24-Hour Average Impact on SP Concentrations for 1990

The predicted impacts from the proposed action mines in 1990 are presented in Map SC4-6. Regionally, simulated SP concentrations range from 5 to approximately 120 $\mu g/m^3$; the highest impacts are predicted to occur in the vicinity of the mine sites. In the Rock Springs area, worst-case predicted SP levels are generally determined from fugitive dust emissions at Black Butte. Similar to 1980 and 1985, emissions from Black Butte are vastly higher than emissions from the Long Canyon mine. Consequently, dispersion of emissions from the Black Butte mine determine predicted impact as a result of the wind direction that lines up Black Butte with such receptors. The only significant influence resulting from Long Canyon emissions is to receptors located very close (within 3 to 5 miles) to the Long Canyon mine. Peak concentrations of approximately 20 $\mu g/m^3$ are predicted to occur about the Long Canyon mine. These concentrations result from a northerly wind flow dispersing emissions from Long Canyon. Concentrations of 20 $\mu g/m^3$ are also simulated to occur 12 miles southeast of Long Canyon. These predicted levels are attributable to the Black Butte mine influenced by an east-southeast wind direction. Maximum SP levels of 120 $\mu g/m^3$ are predicted to occur about the Black Butte mine. These levels are associated with winds from the west-southwest. Elsewhere within the Black Butte subregion, predicted concentrations are generally dominated by dispersion of Black Butte's fugitive dust emissions.

In the western half of the ES region, Map SC4-6 indicates significant impact resulting from north and south wind flow. Because of the relative locations of North Block, Twin Creek, and South Haystack, both northerly and southerly winds result in the interaction of pollutants dispersing from all three surface mines. Such interaction is seen to affect simulated SP concentrations approximately 60 miles north and south of Kemmerer. Interaction between the South Haystack mine and the North Block-Twin Creek mining subregion is small or nonexistent under easterly or westerly wind flow. In general, predicted levels east or west of South Haystack (within about 40 miles) are dominated by fugitive dust emissions dispersing from the South Haystack mine. Similarly, predicted levels within about 50 miles east or west of North Block and Twin Creek are a function of emissions emanating from these two mines. However, in 1990, emissions from the Twin Creek mine are almost three times higher than estimated emissions from North Block; therefore, Twin Creek has greater influence in this subregion. Maximum predicted SP concentrations in this subregion are approximately 120 $\mu g/m^3$. However, an isolated peak concentration of 264 $\mu g/m^3$ is predicted to occur 2 miles south of Twin Creek. Note that emissions from both the Twin Creek and North Block mines decrease from 1985 to 1990 by approximately 17%. Because of its high emission rate (see Table SC4-3), the Twin Creek mine dominates predicted concentrations in this subregion.

Predicted SP levels about the South Haystack mine range from 20 to 80 $\mu g/m^3$. Again, interaction between mines is apparent with north and south wind directions. However, within approximately 3 miles of the mine, the major portion of simulated concentrations are attributable to South Haystack. This is the case in all subregions; the interactive effect between mines is not significant at receptors located close to the mine site.

Concentrations of SP predicted to occur throughout the Class I Bridger Wilderness Area are on the order of 1 $\mu g/m^3$, which is well below the 10 $\mu g/m^3$ allowable PSD increment. The allowable PSD increment for the rest of southwest Wyoming (designated Class II) is maintained on a regional basis except in the near vicinity of the surface mines. Except for Long Canyon, predicted SP levels within 6 to 12 miles of the mine sites exceed the 37 $\mu g/m^3$ increment.

The Flaming Gorge Recreational Area shown on Map SC4-6 and the Fossil Butte National Monument (located approximately 10 miles northwest of Kemmerer) are currently Class II regions but may be redesignated to Class I. Concentrations of SP less than 5 $\mu g/m^3$ are predicted to occur throughout the Flaming Gorge Area, which complies with the Class I 10 $\mu g/m^3$ increment. Predicted levels at Fossil Butte are approximately 20 $\mu g/m^3$, which complies with the Class II increment but exceeds the allowable Class I increment.

Impact from the most probable level of mining development in 1990 is indicated for the NA trona patch, 6 miles north of Green River. As indicated in Map SC4-6, predicted concentrations in this area are on the order of 5 $\mu g/m^3$, which is approximately 2% of the 260 $\mu g/m^3$ federal standard.

Gaseous Pollutants

Vehicle emissions would be the only source of gaseous air pollutants attributable to the proposed action mines. Federal and state regulations include limitations on ambient air concentrations of the vehicle-related pollutants: CO, HC, NO_2, and SO_2.

Ambient concentrations were not modeled because of the lack of detailed data on vehicle use and applicable background data for these pollutants. However, recent studies (U.S. Department of the Interior 1976) of the impact of vehicle emissions associated with western coal mines were reviewed to estimate the probable range of impact. In these studies, concentrations of the above pollutants for similar mining operations had either been modeled or estimated from standard approximation techniques. In all cases, the levels of maximum pollutant concentrations from vehicle emissions were insignificant when compared to standards.

Maximum predicted concentrations of CO ranged between 0.02 and 0.44% of the 1-hour 40,000 $\mu g/m^3$ standard. Maximum predicted HC concentrations ranged between 0.88 and 3.44% of the 3-hour 160 $\mu g/m^3$ standard. Maximum predicted NO_2 concentrations ranged between 0.60 and 3.0% of the standards, while maximum predicted concentrations of SO_2 ranged between 0.02 and 0.33% of the standards. (Air quality standards for SO_2 and NO_x are depicted in Table SC4-9.) The values represent predictions at less than one-half mile from the mines. Predictions were significantly less at distances further from the mines. Assuming similar vehicle activity for all western coal mines, the regional cumulative impact of vehicle emissions on ambient concentrations of gaseous pollutants would be minimal and insignificant compared to their respective standards.

Cumulative Impacts on Air Quality

Cumulative impacts refers to TSP concentrations attributable to the proposed action mines, plus the private, projected mines (Winton and Reliance) plus projected background. Winton and Reliance were modeled similarly to the proposed action mines, and predicted impacts were determined. Background is defined as the conglomeration of SP levels attributable to all sources throughout the ES region other than the proposed mines that were modeled. The resultant total concentrations characterize predicted ambient air quality; hence, these totals may be directly compared to both the federal and Wyoming ambient air quality standards shown in Table SC4-9. The simulated annual and 24-hour

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TABLE SC4-9

STATE OF WYOMING AND NATIONAL AMBIENT AIR QUALITY STANDARDS FOR CONCENTRATIONS OF TSP, SO_2, AND NO_2

Pollutant	Averaging Time	Standard ($\mu g/m^3$)		
		Federal		Wyoming
		Primary*	Secondary**	
TSP	Annual†	75	60§	60
	24-Hour††	260	150	150
SO_2	Annual§§	80		60
	24-Hour††	365		260
	3-Hour††		1,300	1,300
NO_2	Annual§§	100	100	100

*Requisite to protect human health.

**Requisite to protect the public welfare from any known or anticipated adverse effects.

†Geometric Mean

††Not to be exceeded more than once per year.

§Guideline

§§Arithmetic Mean

average SP levels attributable to the proposed actions alone were discussed in previous sections. The background SP concentrations to be added to the proposed action and Winton and Reliance mine simulations for each analysis year are presented in Table SC4-10. These levels are categorized as representative of rural, industrial, or urban background within each county in the ES region.

In general, the industrial category corresponds to the area along Interstate 80 between Little America and Rock Springs, where several point sources are located (this area is referred to as the "trona patch") and the areas in the near vicinity of the Naughton and Bridger Power Plants. The urban category characterizes background about the urban areas within the ES region, such as Rock Springs, Kemmerer, Evanstan, and Green River. Rural background corresponds to the remainder of southwest Wyoming. Background levels presented in Table SC4-10 exhibit a wide range within each category indicative of a large degree of uncertainty associated with regional background levels. As discussed in the Chapter 2 Regional Technical Report, these background concentrations are derived from a small number of monitors within the region and the background ranges presented in Table SC4-10 are merely approximations of trends in regional TSP air quality. Note, however, that the geographical representativeness of a particulate monitor is limited, and background levels at locations relatively distant from the monitors could be quite different.

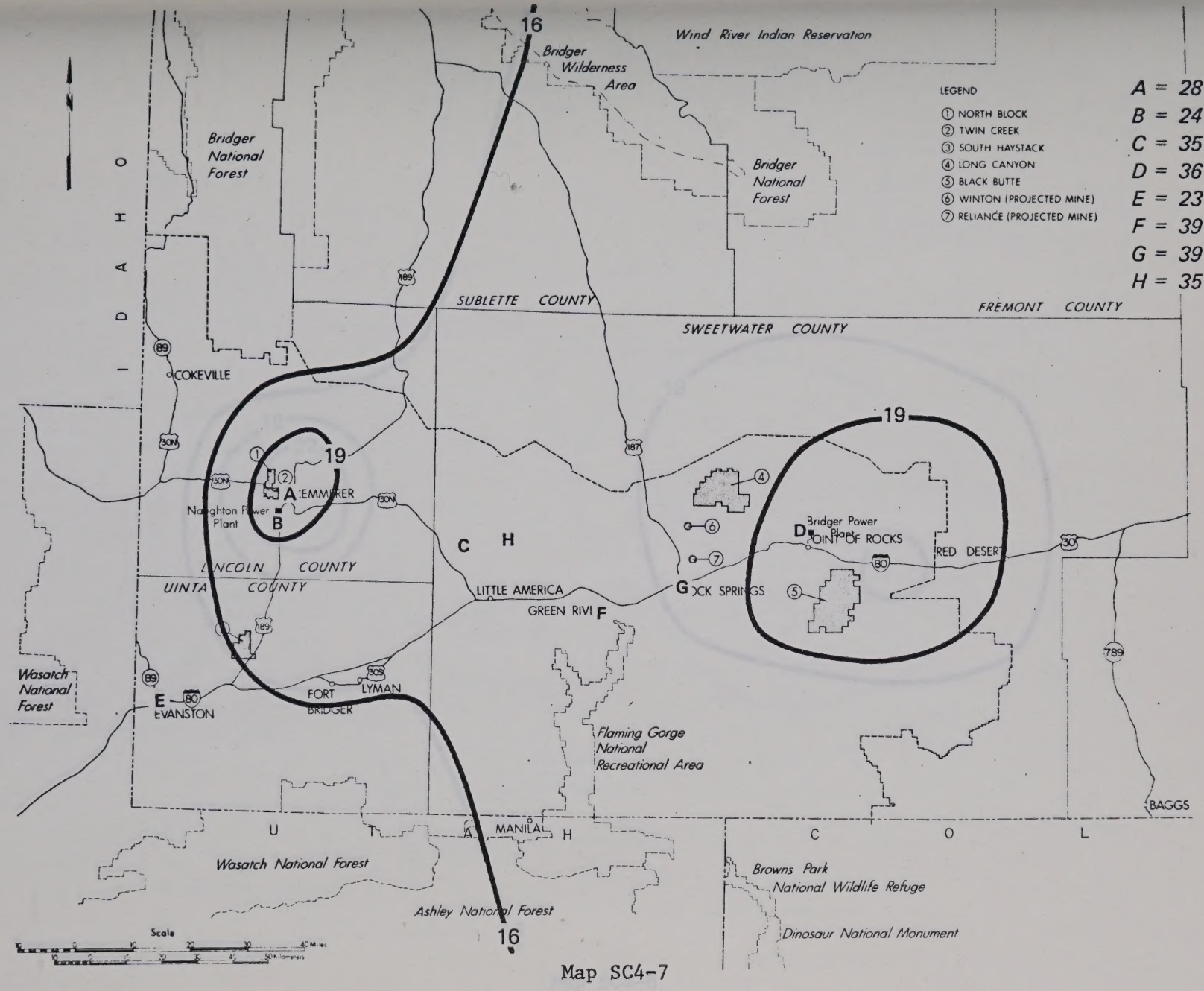
For short-term averages, it is unlikely that the meteorology corresponding to the measured background concentrations is coincident with the 24-hour period determining worst-case impacts attributable to the proposed actions. Without coincident meteorology, the predicted cumulative impacts could not possibly occur. However, in an attempt to quantify cumulative TSP impacts, such worst-case assumptions have been made. Pictorial representations of cumulative regional TSP impacts on annual and 24-hour average concentrations are shown in Maps SC4-7 through SC4-12 for all three analysis years. The depicted isopleths represent simulated SP levels attributable to the proposed action and the Winton and Reliance mines in combination with the mid-points of the background ranges given in Table SC4-10. Use of these background range mid-points is purely arbitrary and for illustrative purposes only; the likelihood of its actual occurrence is unknown. The reader can just as easily choose any point within the given ranges to determine cumulative impacts. Maps SC4-7 through SC4-12 are characterized by a gross smoothing effect in comparison with the maps depicting impact from the proposed actions alone. The domination of background accounts for such TSP distributions.

The basis for determining cumulative TSP impacts must be stressed prior to evaluation. Namely, ambient particulate levels measured at a limited number of available monitors are assumed to characterize background concentrations throughout the entire ES region, and meteorology is assumed to be coincident for background levels and simulated SP impacts attributable to the proposed actions. Cumulative TSP impact discussions that follow delineate a range of predicted concentrations in accordance with Table SC4-10, since at any distance from an existing monitoring site, the true deviation of regional background levels is unknown.

TABLE SC4-10

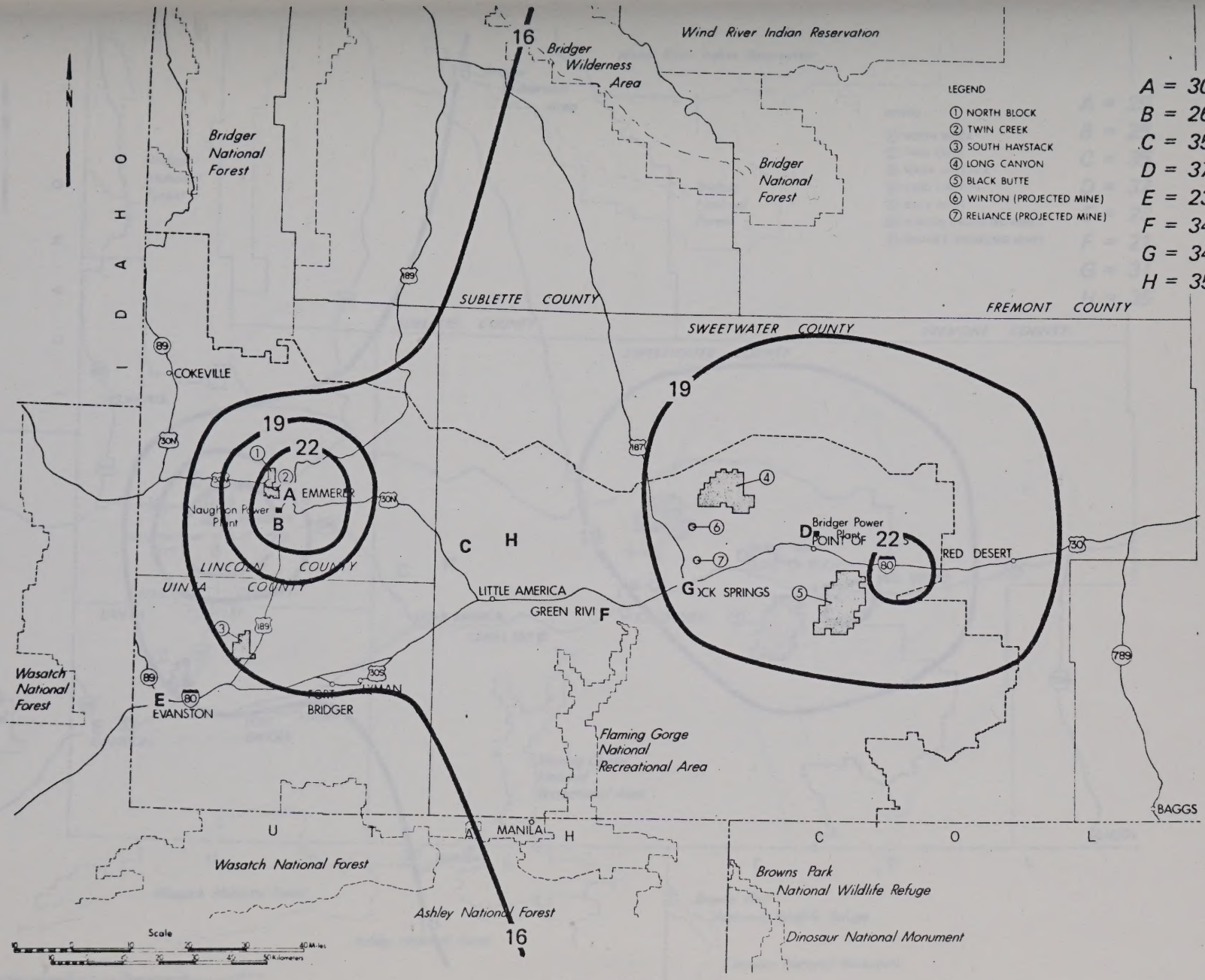
BACKGROUND TSP CONCENTRATIONS
($\mu g/m^3$)

Period of Interest	TSP Averaging Period	Sweetwater County			Lincoln/Uinta Counties		
		Rural TSP	Industrial TSP	Urban TSP	Rural TSP	Industrial TSP	Urban TSP
Baseline	Annual	10-20	20-35	35-45	10-20	20-35	20-35
	24-Hr	35-50	45-160	80-155	30-45	60-85	60-85
1980	Annual	13-23	23-45	33-43	10-20	18-28	18-28
	24-Hr	30-55	60-225	70-130	30-50	50-75	50-75
1985	Annual	13-23	23	28-38	10-20	18-28	18-28
	24-Hr	30-55	60-225	55-110	30-50	50-75	50-75
1990	Annual	13-23	23	25-35	10-20	18-28	18-28
	24-Hr	30-55	60-225	50-100	30-50	50-75	50-75



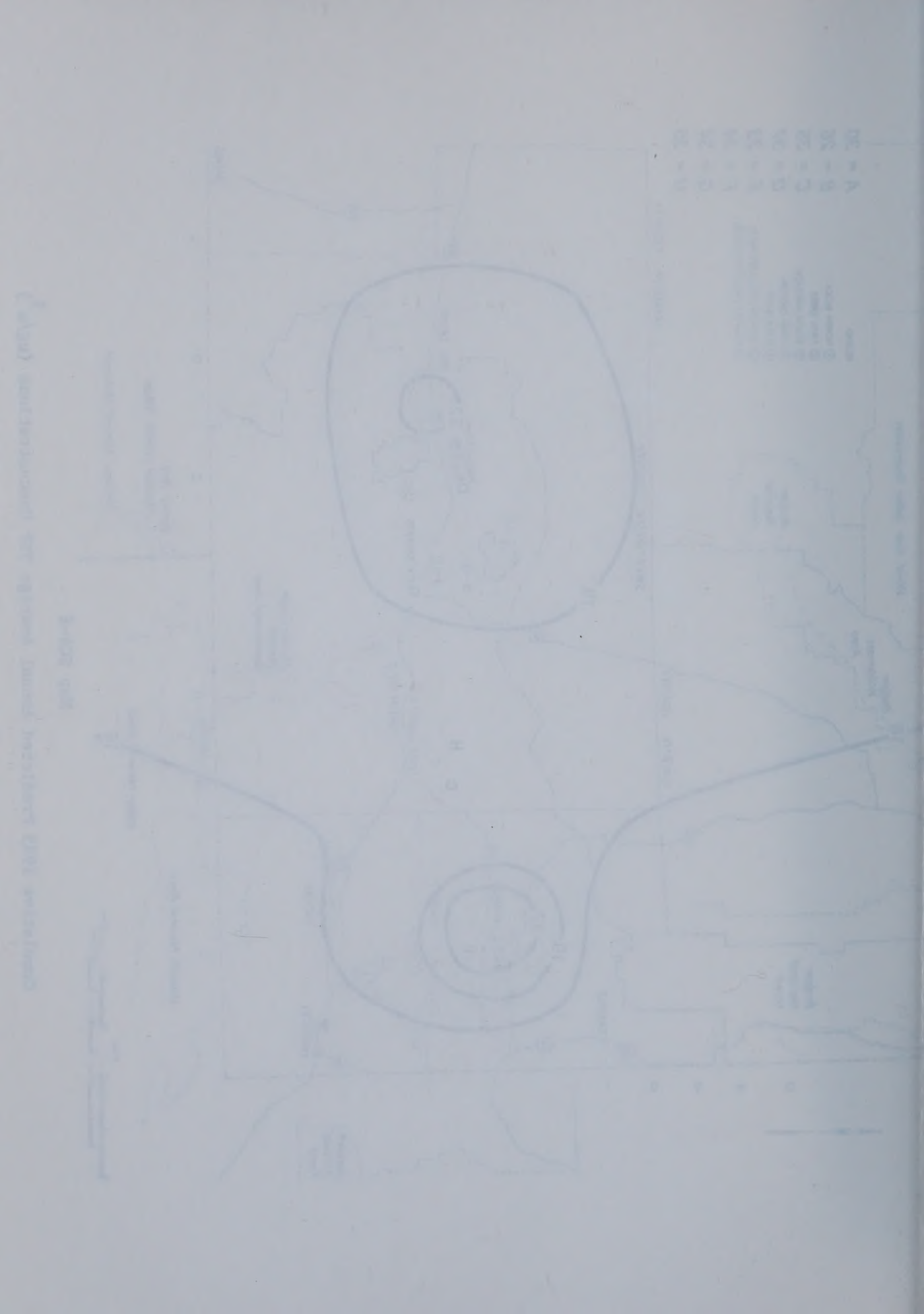
Map SC4-7

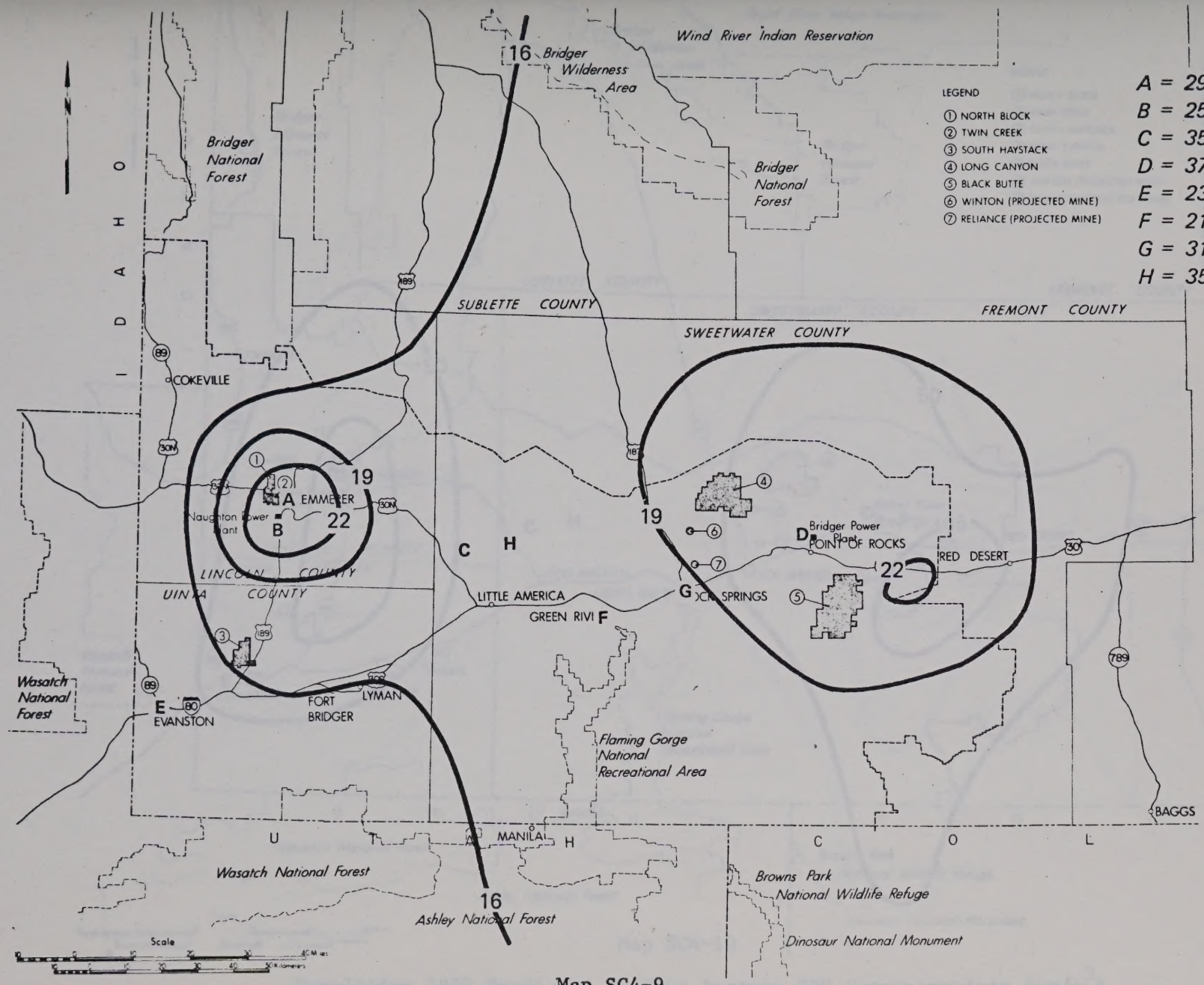
Cumulative 1980 Predicted Annual Average TSP Concentrations ($\mu g/m^3$)



Map SC4-8

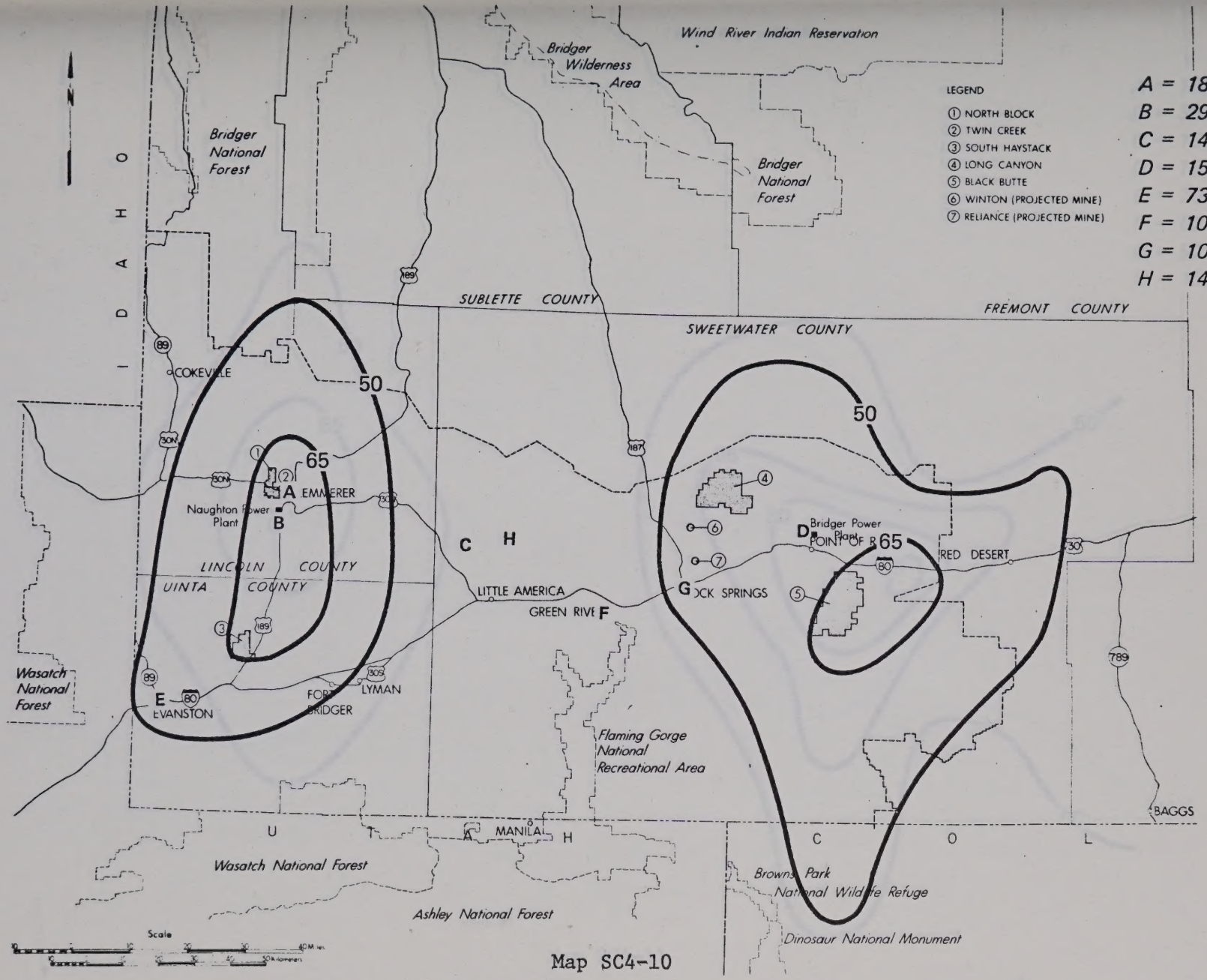
Cumulative 1985 Predicted Annual Average TSP Concentrations ($\mu g/m^3$)





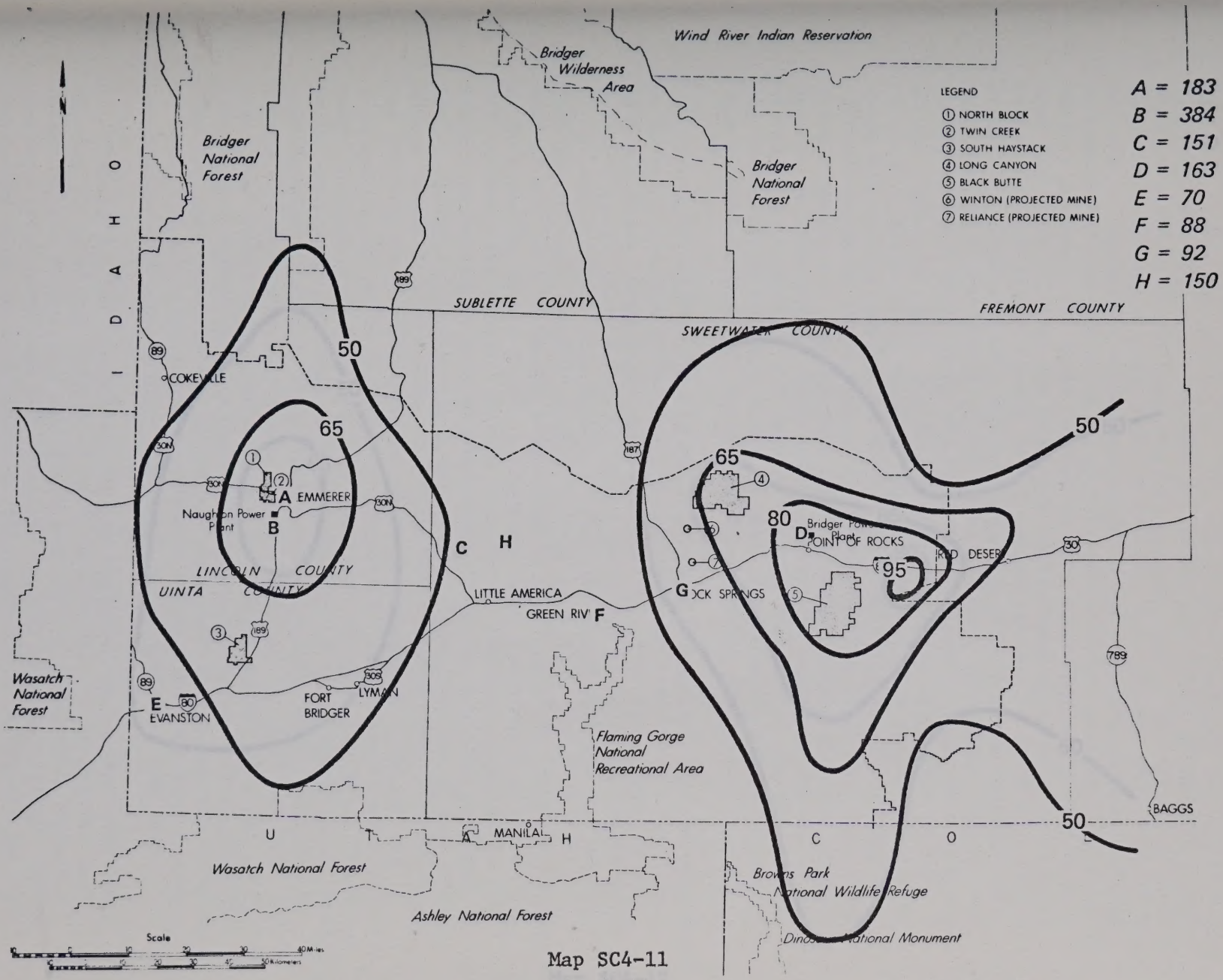
Map SC4-9

Cumulative 1990 Predicted Annual Average TSP Concentrations ($\mu g/m^3$)

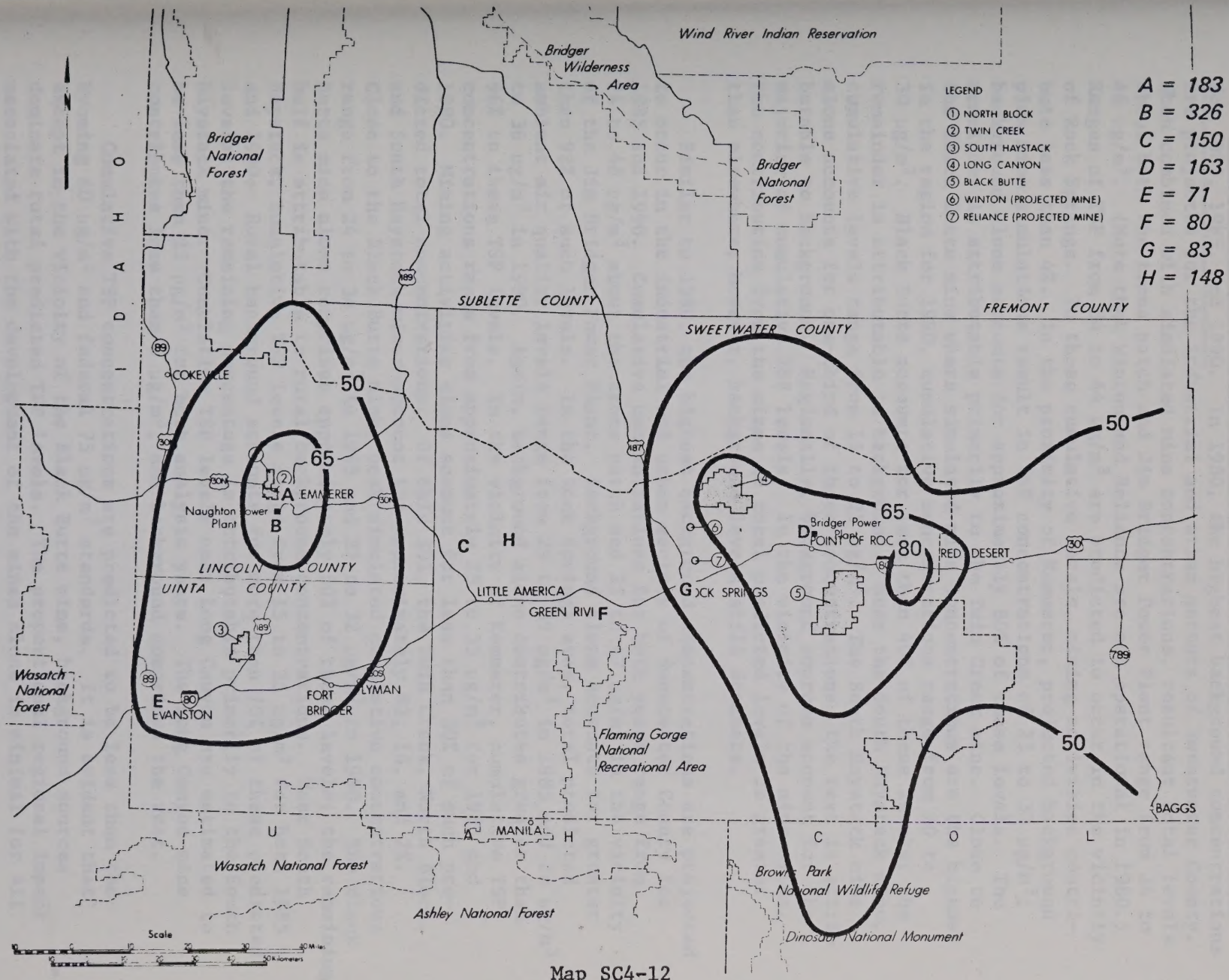


Map SC4-10

Cumulative 1980 Predicted 24-Hour Average TSP Concentrations ($\mu g/m^3$)



Cumulative 1985 Predicted 24-Hour Average TSP Concentrations ($\mu g/m^3$)



Map SC4-12

Cumulative 1990 Predicted 24-Hour Average TSP Concentrations ($\mu g/m^3$)

Predicted Annual Average Cumulative Impacts on TSP Concentrations for 1980, 1985, and 1990. In 1980, the highest background concentrations are projected for the industrial and urban sectors of Sweetwater County. When combined with simulated mine concentrations, resultant total levels about both the trona patch and Jim Bridger Power Plant range from 24 to 46 $\mu g/m^3$. (Note that Winton and Reliance are not operational in 1980.) Ranges of TSP from 34 to 44 $\mu g/m^3$ are predicted to occur in the vicinity of Rock Springs. To these cumulative totals, mining activities contribute less than 4%. In the proximity of Kemmerer, projected background plus mine simulations result in TSP concentrations of 23 to 33 $\mu g/m^3$; background alone accounts for approximately 80% of these levels. The remainder is attributable primarily to the Twin Creek mine. Close to the Black Butte mine where simulated mine concentrations are the highest in the region for 1980, cumulative concentrations range from 20 to 30 $\mu g/m^3$. Black Butte accounts for less than 40% of these levels; the remainder is attributable to background. Near the South Haystack mine, cumulative levels range from 15 to 25 $\mu g/m^3$. The South Haystack mine alone accounts for one-third of these concentrations, the rest is attributable to background. Regionally, background sources account for the majority of cumulative TSP levels. In the vicinity of the mine sites, the contribution from the mines to total predicted levels is greater than elsewhere; however, background levels still dominate.

Similar to 1980, the highest background concentrations are projected to occur in the industrial and urban sectors of Sweetwater County for 1985 and 1990. Cumulative concentrations for both years range from 24 to 46 $\mu g/m^3$ about the trona patch and 25 to 47 $\mu g/m^3$ in the vicinity of the Jim Bridger Power Plant. Background alone accounts for greater than 92% of such levels. In the Rock Springs area, total predicted ambient air quality levels range from 29 to 39 $\mu g/m^3$ in 1985 and 26 $\mu g/m^3$ to 36 $\mu g/m^3$ in 1990. Again, background alone contributes greater than 96% to these TSP levels. In the vicinity of Kemmerer, cumulative TSP concentrations range from approximately 25 to 35 $\mu g/m^3$ for 1985 and 1990. Mining activities alone account for less than 30% of such predicted total concentrations. Of this 30%, the Twin Creek, North Block, and South Haystack mines account for approximately 82, 16, and 2%. Close to the Black Butte mine, peak simulated cumulative concentrations range from 24 to 34 $\mu g/m^3$ in 1985 and 22 to 32 $\mu g/m^3$ in 1990. The Black Butte mine alone comprises approximately 50% of these levels; the remaining half is attributable to rural background concentrations. Near South Haystack, cumulative TSP levels range from 15 to 25 $\mu g/m^3$ for both 1985 and 1990. Rural background accounts for more than 70% of these predicted levels; the remaining percentage is attributable primarily to the South Haystack mine. Cumulative TSP levels near Long Canyon are estimated to be less than 22 $\mu g/m^3$ for both analysis years. The Long Canyon mine contributes less than 2 $\mu g/m^3$, and background comprises the rest.

Cumulative TSP concentrations are predicted to be less than the Wyoming 60 $\mu g/m^3$ and federal 75 $\mu g/m^3$ standards. It is evident that except in the vicinity of the Black Butte mine, background sources dominate total predicted TSP levels. The proportional regional impact associated with the development of the mines alone is minimal for all three analysis years.

Predicted 24-Hour Average Cumulative Impacts on TSP Concentrations for 1980, 1985, and 1990. Maximum background concentrations in 1980 are projected to occur throughout the industrial sections of Sweetwater County. As depicted in Table SC4-10, the upper background limit of 225 $\mu g/m^3$ is greater than the Wyoming 150 $\mu g/m^3$ standard. When combined with the worst-case simulated mine concentrations, resultant total concentrations range from 64 to 229 $\mu g/m^3$ in the trona patch and 70 to 235 $\mu g/m^3$ about the Jim Bridger Power Plant. Background alone accounts for a major portion of these totals. The only mine contributing to total levels about the Jim Bridger Power Plant is Black Butte, which accounts for approximately 10 $\mu g/m^3$. The second highest background concentrations are projected to occur in the urban areas of Sweetwater County. In the vicinity of Rock Springs, total cumulative levels range from 75 to 135 $\mu g/m^3$; background alone accounts for greater than 90% of these levels. As indicated in earlier sections, maximum mine simulated concentrations of 227 $\mu g/m^3$ occur less than 2 miles south of Twin Creek. When combined with projected background, resultant total concentrations range from 277 to 302 $\mu g/m^3$. The Twin Creek and North Block mines line up under the influence of a northerly wind flow to account for greater than 80% of these total concentrations. Emissions emanating from Twin Creek dominate the 80% mine contribution since the estimated Twin Creek emission rate is more than seven times higher than North Block's. In Kemmerer, located approximately 2 miles east of Twin Creek, predicted cumulative TSP levels range between 170 and 195 $\mu g/m^3$. The Twin Creek (predominately) and North Block mines contribute approximately 120 $\mu g/m^3$ to these levels, indicating that the contribution from background is less than 30%. Within approximately 6 miles north, south, and east of Twin Creek, cumulative TSP levels are predicted to be greater than the Wyoming 150 $\mu g/m^3$ 24-hour average standard, attributable primarily to the Twin Creek mine.

North-northeast of the Black Butte mine, peak mine simulations are on the order of 80 $\mu g/m^3$. When combined with rural background, cumulative TSP concentrations range from 110 to 135 $\mu g/m^3$. It is evident that emissions emanating from Black Butte comprise a major portion of these levels. Maximum mine simulations about South Haystack are also on the order of 80 $\mu g/m^3$. When combined with Uinta County rural background, total predicted TSP levels range from 110 to 130 $\mu g/m^3$ to which the South Haystack mine contributes more than 60%. Cumulative levels about the Long Canyon mine are low, ranging from 55 to 75 $\mu g/m^3$. Long Canyon contributes approximately 10 to 20 $\mu g/m^3$ to such levels, the remainder is attributable to rural background in Sweetwater County. Elsewhere within the ES region, cumulative TSP levels are predicted to be lower than the 150 $\mu g/m^3$ Wyoming standard and become quite low as the distance from the actual mine sites increases. At the same time, background concentrations dominate cumulative TSP levels with increasing distance from the sites, as is evident from Maps SC4-3 and SC4-10.

Projected background concentrations for 1985 and 1990 are identical to 1980, with the exception of urban TSP levels in Sweetwater County. Maximum background concentrations ranging from 60 to 225 $\mu g/m^3$ are projected to occur throughout the industrial sectors of Sweetwater

County. When combined with ERTAQ-simulated mine contributions, cumulative TSP levels range from approximately 66 to 231 $\mu g/m^3$ in the trona patch and 80 to 245 $\mu g/m^3$ near the Jim Bridger Power Plant for both analysis years. Background alone accounts for a major portion of these totals. Black Butte (accounting for approximately 20 $\mu g/m^3$) is the only mine contributing to cumulative levels about the Jim Bridger Power Plant. The second highest background levels are projected to occur in the urban sections of Sweetwater County. In the proximity of Rock Springs, cumulative TSP concentrations are predicted to range from 65 to 120 $\mu g/m^3$ in 1985 and 57 to 157 $\mu g/m^3$ in 1990. Background alone comprises more than 85% of these levels; the Black Butte mine primarily comprises the remaining percentage. Maximum ERTAQ-simulated concentrations of 322 and 264 $\mu g/m^3$ occur less than 2 miles south of Twin Creek. When combined with projected background, cumulative levels range from 372 to 397 $\mu g/m^3$ in 1985 and 314 to 339 $\mu g/m^3$ in 1990. The Twin Creek and North Block mines influenced by a northerly wind flow line up to account for more than 84% of such total TSP levels. Emissions emanating from Twin Creek in 1985 and 1990 are approximately three times higher than North Block's; and, hence, Twin Creek dominates the 84% mine contribution. In Kemmerer, located about 2 miles east of Twin Creek, ranges of 170 to 195 $\mu g/m^3$ are indicative of calculated cumulative impacts for 1985 and 1990. The Twin Creek (predominately) and North Block mines account for 120 $\mu g/m^3$, indicating that the contribution from background is less than 30%. Within approximately a 6 mile radius of the center of Twin Creek, as depicted in Maps SC4-5 and SC4-6, cumulative TSP concentrations are predicted to be greater than the Wyoming 150 $\mu g/m^3$ standard, attributable primarily to the Twin Creek mines.

North-northeast of Black Butte, peak mine simulations are on the order of 120 $\mu g/m^3$ for 1985 and 1990. When combined with Sweetwater County rural background, total predicted ambient levels range from 150 to 175 $\mu g/m^3$, which is greater than the Wyoming standard but less than the NAAQS. Emissions emanating from Black Butte comprise a major portion of these totals. Second highest simulated cumulative TSP levels about Black Butte range from 110 to 135 $\mu g/m^3$, to which the Black Butte mine contributes more than 60%. Maximum mine simulations are also on the order of 80 $\mu g/m^3$ within 3 miles about South Haystack for analysis years 1985 and 1990. When combined with Uinta County rural background, ranges of 110 to 130 $\mu g/m^3$ characterize cumulative TSP levels. The South Haystack mine alone comprises more than 60% of these total concentrations. Cumulative levels about the Long Canyon mine are similar to 1980, ranging from 55 to 75 $\mu g/m^3$. Long Canyon contributes approximately 10 to 20 $\mu g/m^3$ to such levels, the remainder is attributable to rural background in Sweetwater County. Elsewhere in the ES region, cumulative TSP levels are predicted to be lower than the 150 $\mu g/m^3$ Wyoming standard, and become quite low as distance from the mine sites increases. As in 1980, background levels dominate predicted cumulative levels with increased distance from the mine sites.

Blasting and coal fires are other potential sources of particulate emissions. The impact of these sources is difficult to assess, although the maximum air quality degradation would occur on a very local scale.

The cloud of dust produced by blasting would be short-lived, at least compared to the averaging times of the TSP standards (24 hours or greater), so that little contribution to 24-hour levels would be measured inside or outside the mine site. The dust produced would also be initially dispersed to a greater degree by the force of the explosion. Blasting would generally take place during the day when meteorological characteristics are most favorable for dispersing ground-level pollutants. Coal fires would also occur in spite of measures employed to avoid them. If neglected and allowed to burn out of control for long periods, they could significantly degrade the quality of air, although on a local scale. Estimate of frequency or quantity of emissions cannot be made. However, due to high degree of fire control technologies, potential impacts would probably be minimal.

If reclamation fails at one study site due to a natural catastrophe and the area disturbed by mining operations is not revegetated, particulate emissions could be greatly increased. These impacts would be primarily local and regional effects would be minimal.

Region-wide failure of revegetation could occur during a severe drought and, consequently, have a significant impact on ambient air quality. The frequency of severe droughts in southwest Wyoming is on the order of three months per year as discussed in Chapter 2. However, the assumption that mulching and planting occur in the Fall is inherent in the impact results depicted in Maps SC4-1 through SC4-12. Therefore, if the three-month drought period were to occur in the Fall, TSP concentrations would be higher than those described in the impact chapter. However, the likelihood of a Fall drought and resultant negative effects on predicted worst-case impacts associated with mining and reclamation processes is unknown.

In general, cumulative impacts on gaseous pollutants (CO, HC, NO_2, and SO_2) are insignificant when compared to standards. Cumulative impacts on CO and HC cannot be quantified due to the lack of monitoring data. However, such total impacts are not expected to significantly differ from impacts associated with the proposed actions alone. Rural background NO_2 and SO_2 levels are quite low (less than 7% and 2% of corresponding state and federal standards, respectively) as discussed in Chapter 2. When combined with concentrations associated with the proposed actions, cumulative levels are well below NO_2 and SO_2 standards.

Indirect Air Quality Impacts

Additional air pollutant emissions would result from sources related to the proposed coal development. These indirect sources include:

- new or expanded housing;
- new roadways and increased traffic;
- new or expanded commercial activities;

- expansion of existing power plants; and
- construction activities.

The Jim Bridger and Naughton Power Plants, situated in Sweetwater and Lincoln counties, respectively, are the only existing power plants located within the ES region. The expansion of the Jim Bridger Power Plant and the proposed expansion of the Naughton Power Plant are expected to increase particulate emissions by 25% and 20%, respectively. Emissions attributable to the remaining indirect sources listed above were based on population growth associated with mining development; population is estimated to increase by 31%, 50%, and 51% in 1980, 1985, and 1990, respectively. Therefore, ground-level TSP concentrations should increase in all areas but not in a homogeneous spatial pattern. Consequently, a range of baseline (1975) TSP levels typical of rural, industrial, and urban areas was evaluated and projected to the future. These projected baseline values depicted in Table SC4-8 are inherent in the background concentrations used to determine the cumulative impacts associated with the most probable level of mining development. A detailed discussion of the derivation of the values is presented in the Chapter 2 Regional Technical Report.

Quantitative impacts of the proposed mines to variations in baseline SO_2 and NO_x concentrations are unknown; however, the contributions from the proposed mines are expected to be negligible. The impact of the indirect sources listed above on baseline SO_2 and NO_x concentrations is discussed in the Chapter 2 Regional Technical Report.

Concluding Statement

The significance of the results presented in the previous sections revolves around several uncertainties inherent in the emission factor and modeling analysis as well as several questions concerning the interpretation of specific standards, the characteristics of the SP, and the classification of surrounding lands:

1) It is evident that the reliability rating of current state-of-the-art fugitive dust emission factors is highly questionable. In fact, the majority of these factors have been rated "poor," according to the EPA. Such factors are qualified as supportable by best engineering judgment, involving visual observation and judgmental adjustments to results of emissions tests conducted at noncoal mining sources. When combined with the questionable accuracy of input data for the mines, the state-of-the-art fugitive dust emission factor analysis is extremely limited and, therefore, the results obtained in this study are useful only from an order of magnitude or comparative perspective.

2) As detailed in the section entitled "Uncertainties Associated with Modeling of Fugitive Dust Emissions," there are many uncertainties inherent in the modeling analysis. Those model input items casting doubt on the absolute values of predicted TSP concentrations presented in the previous section include:

- Nonsite-specific meteorology
- Constant emission rates
- Source-receptor geometries that do not detail site-specific operational activities
- Assumption of a 30 foot initial mixing volume for area sources representing the mines
- Assumption of flat terrain throughout the ES region
- Lack of a fugitive dust deposition function

3) Primary NAAQS are intended to protect public health with an adequate margin of safety. Aside from the chemical toxicity of particulate matter, the main parameter affecting human health is particle size. Practically all particles with diameters greater than 10 μm are filtered from the air by hairs in the nasal passage and the mucous lining in the nasal cavity and trachea. Particles smaller than about 5 μm in diameter escape the defense mechanisms of the upper respiratory system and enter the lung. Of these, the diameters most effectively retained in the lungs are less than 1.0 μm. Thus, the primary standard should focus on submicron particles. To ensure an adequate margin of safety, the standard should address particles less than 5 μm in diameter.

4) The EPA fugitive dust policy (1977) says that the particulate matter typically found in rural areas, without the impact of major industrial developments, is native soil that for various reasons becomes airborne. It is generally not exposed to potential contaminations by industrial pollutants that commonly occur in urban atmospheres. The toxicity and, consequently, the related health effects of fugitive native soil particulates is probably less than that represented by the ambient health standards. It is therefore possible that the standard may be too restrictive for evaluating the impact of mining, since the majority of dust emissions are from native soil (i.e., overburden, topsoil, and haul roads).

5) Current federal PSD standards are specified as maximum allowable increments to baseline air quality for major emitting facilities. Current regulations do not explicitly define strip-mining operations as major emitting facilities, although

they typically emit more than the recommended classification point of 100 tons per year of pollutant. The question revolves around the interpretation of natural as opposed to man-made fugitive dusts. Since natural effects are included in emission estimates (e.g., wind blown dusts), it is unclear what portion of mine-related emissions should be subject to PSD standards.

6) Baseline or "background" air quality levels of TSP employed in the analysis are derived from the few available monitors within the region, which in some cases, are located at significant distances from the mines. Note that especially for particulate matter, the geographical representativeness of a given monitor is often somewhat limited; i.e., just because a monitor records high concentrations, it is not necessary to assume that such concentrations occur over a wide geographical area. Therefore, although this assumption was used in the present analysis, the predicted total ambient TSP levels (source and background) at locations where no monitoring is available are questionable.

Probable Cumulative Regional Impacts

A brief enumeration on the transport of aerosols and their possible effects on climate is presented in the Regional Technical Report. However, the available data do not provide a firm basis for statements about what role the proposed coal development activities would play in altering the ES region's existing climate over the next fifteen years. Increases in suspended particulates concentration will be above background in the immediate vicinity of the mines, but computations show that it is doubtful whether at distances more than 35 miles from the source these increases could be detected against the natural variability of background concentrations of particulate matter. Near the mines and under certain meteorological conditions, atmospheric nuclei* could be increased on a local scale, but little can be said with certainty for inadvertent modifications resulting from radiative transfer and precipitation formation because the following variables are not known:

- the chemical composition and physical structure of these particles being introduced;
- the size distribution of the particles being introduced;
- the increase in the number of aerosol particles over the natural intrusion;

*Atmospheric nuclei refers to minute suspended particles that serve as a substrate for the formation of cloud droplets or ice particles.

- the relative effects on the climate of southern Wyoming of other development activities outside the region of interest; and

- no quantifiable rank of importance of different climactic effects.

Visibility

Visibility is subjectively defined as an observer's ability to perceive a distant object against its background. More quantitatively, it is the limiting distance where the threshold for contrast perception is reached for an observer viewing an ideal object. The ability of an observer to discern distant objects is constrained by the capacity of the intervening atmosphere to absorb and scatter visible light emanating from the object within the field of view. Atmospheric extinction properties and their corresponding effect on visibility degradation depend, in a complicated manner, on the optical nature of the ambient air molecules, aerosols, and particulates within the line of sight. Additional anthropogenic sources of particulates, such as those attributable to fugitive dust emissions, will reduce visibility downwind from the immediate source area.

Precise evaluation of the degree of visibility degradation requires a knowledge of several source specific particulate parameters, such as the characteristic number size distribution and optical properties within each size range. Generally, such data vary considerably in time and are usually not available. However, by employing reasonable assumptions, an estimate of visibility degradation can be made using projected TSP concentration. A complete technical description of the model employed is given in Chapter 4 Regional Technical Report.

Using the derived relationship between visibility and TSP concentrations shown in Maps SC4-1 through SC4-6, degradation of visibility throughout the ES region can be addressed. In general, isopleths of visibility and TSP are not coincident, and the derived relationship is strictly valid only for uniform aerosol distributions. It is assumed, however, that sufficiently far from particulates sources, the TSP distribution is relatively homogeneous over the distance of the prevailing visibility. Close to sources where the TSP gradient is greater, use of the visibility relationship will be valid only when the observer looks along a TSP isopleth. Visibility is overestimated when looking into higher TSP regions (toward the source) and underestimated when looking away from the source. The years 1980, 1985, and 1990 are examined. For each year considered, the ERTAQ-simulated regional worst-case 24-hour SP concentrations are partitioned by mass into both coal and soil fractions. The coal and soil mass fractions for each mine considered in the analysis were determined from the annual average emission rates and averaged to obtain annual mean mass fractions of coal

(i.e., the proportion by weight of total annual particulates emitted, which is coal dust). These mean mass fractions of coal corresponding to 1980, 1985, and 1990 are 0.08, 0.27, and 0.27, respectively. Background visibilities for each year are estimated using the projected regional background TSP concentrations depicted in Table SC4-9. In conjunction with current visibility observations, regional background visibilities were determined to be 40 miles for each year. Unaccounted for factors, such as increased levels of regional sulfate or nitrate aerosols, may significantly alter the projected assumed background visibilities, and the reader is cautioned to be aware of such anomolies.

For brevity, specific aspects of the visibility degradation corresponding to the projected TSP distribution are addressed. These include the minimum visibility predicted by the maximum predicted pollutant concentrations within the region and the visibility corresponding to the predicted levels of 20 $\mu g/m^3$. An examination of the TSP maps indicates that most of the ES region has predicted TSP concentrations from fugitive dust sources less than this value. Additionally, Class I areas (Bridger Wilderness Area) and potential Class I areas (Flaming Gorge and Fossil Butte) are examined for significant degradation of visibility.

For 1980, worst-case, 24-hour SP concentrations attain values as high as 227 $\mu g/m^3$ in the vicinity of the proposed North Block and Twin Creek mines. This corresponds to a visibility of 24 miles, when assuming a background of 40 miles. Most of the region, however, is characterized by predicted levels less than 20 $\mu g/m^3$, which corresponds to a visibility of 37.8 miles. This is a reduction of 2.2 miles from the background.

Concentrations in the Bridger Wilderness Area (Class I) are about 1 $\mu g/m^3$. This level of SP yields a visibility of 39.9 miles for a reduction of less than 0.3% from the background. In the vicinity of Flaming Gorge National Recreational Area (Class II), SP values are between 2 and 4 $\mu g/m^3$, giving visibilities of 39.5 miles (visibility degradation 1.2%). At Fossil Butte, where concentrations are approximately 20 $\mu g/m^3$, the computed visibility and visibility degradation are 37.8 miles and 5.5%, respectively.

For 1985, worst-case 24-hour SP concentrations attain values as high as 322 $\mu g/m^3$ in the vicinity of the proposed North Block and Twin Creek mines. This corresponds to a visibility of 20.1 miles, assuming a background of 40 miles. Most of the region, however, is characterized by predicted levels less than 20 $\mu g/m^3$, which corresponds to a visibility of 37.7 miles. This is a reduction of 2.3 miles from the background.

Concentrations in the Bridger Wilderness Area (Class I) are between 1 and 2 $\mu g/m^3$. This level of SP yields a visibility of 39.8 miles for a reduction of less than 0.7% from the background. In the vicinity of Flaming Gorge National Recreational Area (Class II), SP values are between 4 and 5 $\mu g/m^3$, giving visibilities of 39.4 miles (visibility

degradation 1.5%). At Fossil Butte, concentrations are approximately 32 $\mu g/m^3$. The computed visibility and visibility degradation are 36.4 miles and 8.9%, respectively.

For 1990, worst-case 24-hour SP concentrations attain values as high as 264 $\mu g/m^3$ in the vicinity of the proposed North Block and Twin Creek mines. This corresponds to a visibility of 22.1 miles, assuming a background of 40 miles. Most of the region, however, is characterized by predicted levels less than 20 $\mu g/m^3$, which corresponds to a visibility of 37.7 miles. This is a reduction of 2.3 miles from the background.

Concentrations in the Bridger Wilderness Area (Class I) are about 1 $\mu g/m^3$. This level of SP yields a visibility of 39.9 miles for a reduction of less than 0.3% from the background. In the vicinity of Flaming Gorge National Recreational Area (Class II), SP values are between 3 and 4 $\mu g/m^3$, giving visibility of 39.5 miles (visibility degradation 1.3%). At Fossil Butte, concentrations are approximately 25 $\mu g/m^3$. The computed visibility and visibility degradation are 37.2 miles and 7.1%, respectively.

REGIONAL UNAVOIDABLE ADVERSE IMPACTS

No optional mitigative measures are proposed for the mining projects in southwestern Wyoming. All measures proposed are included in the mining plans. Therefore, all reductions in concentrations associated with mitigation have already been considered in the impacts previously reported. Unavoidable adverse impacts are then equivalent to impacts discussed in Chapter 4.

Wind erosion from unreclaimed land constitutes the most significant single source of fugitive dust from the surface mines (North Block, Twin Creek, South Haystack, and Black Butte), accounting for 20 to 50% of the total emissions. However, this prediction is based on the assumption that planting would begin in the Fall, that surface roughness and sheltering effects are negligible, and that mulching and planting are performed in a one-step operation. If, in fact, the mines do implement mulching and/or planting in the Spring and expect to furrow the land, the TSP emissions from wind erosion would be substantially less.

Overburden removal and storage operations appear to be the most important sources of emissions after wind erosion, accounting for about 25 to 40% of total fugitive emissions. Note that overburden removal constitutes 68% of the total emissions for Black Butte in the final year of coal mining because of the inordinately large amount of overburden material (200 million tons) that must be displaced.

Emissions from haul and access road traffic at the surface mines range from 10% of the total at Twin Creek and Black Butte to about 30% at South Haystack for those years when overburden haulage would be occurring. Unpaved road emissions would only be about 3% of the total for both South Haystack and Twin Creek during those years when overburden would not be hauled.

Emissions from coal handling and storage account for about 2% of the total fugitive emissions at the surface mines and 10 to 15% of the total for the underground mines (Long Canyon and the projected Winton and Reliance mines).

Because overburden removal and truck haulage is not involved in the underground mines; wind erosion, coal handling, and access roads are predicted to account for a significantly higher percentage of the total emissions at these mines compared with the surface mines. Fugitive emissions from underground mines, however, are typically an order of magnitude (or more) lower than surface mine emissions.

Impacts on Air Quality

Cumulative impacts refer to the summation of predicted SP concentrations (attributable to the mines alone) with projected background concentrations. In this study, background is defined as the conglomeration of particulate levels attributable to all sources throughout the ES region other than the proposed mines that were modeled. The resultant total concentrations characterize predicted ambient air quality; and, hence, these totals may be directly compared to both the federal and Wyoming ambient air quality standards.

For annual averaging periods, predicted cumulative TSP concentrations are less than the Wyoming (60 $\mu g/m^3$) and federal (75 $\mu g/m^3$) standards. Except near the Black Butte mine, background sources dominate predicted TSP levels. The proportional regional impact associated with the development of the mines alone is minimal.

The Wyoming 24-hour TSP standard (150 $\mu g/m^3$) may be exceeded in 1980, 1985, and 1990 in several areas in southwest Wyoming. Maximum background concentrations in 1980 are projected to occur throughout the industrial sections of Sweetwater County. The upper background limit of 225 $\mu g/m^3$ is greater than the Wyoming standard. When combined with the worst-case simulated mine concentrations, resultant total concentrations range from 64 to 229 $\mu g/m^3$. It is evident that background alone accounts for a major portion of these totals. The only mine contributing to total levels is Black Butte. The second highest background concentrations are projected to occur in the urban areas of Sweetwater County. In the vicinity of Rock Springs, total cumulative levels range from 75 to 135 $\mu g/m^3$; background alone accounts for greater than 90% of these levels.

South of the Twin Creek mine, cumulative worst-case TSP concentrations range from 277 to 302 $\mu g/m^3$; the Twin Creek and North Block mines account for greater than 80% of these total concentrations. In Kemmerer, located approximately 2 miles east of Twin Creek, predicted cumulative worst-case TSP levels range between 170 and 195 $\mu g/m^3$; the contribution from background is less than 30%. Within approximately 6 miles north, south, and east of Twin Creek, cumulative TSP levels are predicted to be greater than the Wyoming 150 $\mu g/m^3$ 24-hour average standard, attributable primarily to the Twin Creek mine.

North-northeast of the Black Butte mine, cumulative worst-case TSP concentrations range from 110 to 135 $\mu g/m^3$. The emissions emanating from Black Butte comprise a major portion of these levels. Total predicted worst-case TSP levels range from 110 to 130 $\mu g/m^3$ in the vicinity of the South Haystack mine; the mine contributes more than 60%. Cumulative levels about the Long Canyon mine are low. Elsewhere within the ES region, cumulative TSP levels are predicted to be lower than the 150 $\mu g/m^3$ Wyoming standard and become quite low as the distance from the actual mine sites increases. Background concentrations dominate cumulative TSP levels with increasing distance from the sites.

For 1985 and 1990, cumulative TSP concentrations predicted do not differ significantly from those discussed for 1980. However, north-northeast of Black Butte the Wyoming 24-hour average standard (150 $\mu g/m^3$) for TSP may be exceeded in 1985 and 1990. When combined with Sweetwater County rural background, total predicted worst-case ambient levels range from 150 to 175 $\mu g/m^3$. The emissions emanating from the Black Butte mine comprise a major portion of these totals.

Intermittent blasting and spontaneous coal fires could cause unavoidable emissions of particulates to the atmosphere in the vicinity of each of the mines. The degree of impact would depend on the specific blasting operation. If the blasting were not properly sequenced and did not use the minimum amount of explosive, significant local-scale impact could occur. Coal fires could occur in spite of mitigative measures employed to avoid them. If neglected and allowed to burn out of control for long periods, they could significantly contaminate the air. However, due to a high degree of fire control technologies, potential fire impacts would probably be minimal.

If reclamation fails at one study site because of a natural catastrophe and the area disturbed by mining operations is not revegetated, particulate emissions could be greatly increased. However these impacts would be primarily local; regional effects would be minimal.

Gaseous Pollutants

The proposed actions and other potential coal development not in the scope of this analysis would require a large labor force. Exhausts from cars transporting personnel to and from work would be an additional source of HC and CO. In addition, coal support facilities and transportation systems would add to the background levels of these pollutants. Pollution generated by increased population, future industrial activities, and associated urban development would increase air pollutant emissions above present levels. Although these emissions would be an unavoidable addition to background levels, their contribution is insignificant when compared to air quality standards.

Visibility

Particulates, such as those attributable to fugitive dust emissions, reduce visibility in the immediate source area. Visibilities are calculated for 1980, 1985, and 1990, using the projected regional worst-case 24-hour SP concentrations. Background sources and mine-related activities are considered. To assess visibility degradation, regional

background visibilities are assumed to be 40 miles for each year. Class I areas (Bridger Wilderness Area) and potential Class I areas (Flaming Gorge and Fossil Butte) are examined for significant degradation of visibility.

For 1980, worst-case, 24-hour SP concentrations attain values as high as 227 $\mu g/m^3$ in the vicinity of the proposed North Block and Twin Creek mines. This corresponds to a visibility of 24 miles, assuming a background of 40 miles. Most of the region, however, has a projected visibility of 37.8 miles, a reduction of 2.2 miles from the background. The computed visibility in the Bridger Wilderness Area is 39.9 miles in 1980 for a reduction of less than 0.3% from the background. In the vicinity of Flaming Gorge National Recreational Area predicted visibilities are in the range of 39.5 miles (visibility degradation 1.2%). At Fossil Butte, the computed visibility and visibility degradation are 37.8 miles and 5.5%, respectively.

For 1985, in the vicinity of the proposed North Block and Twin Creek mines visibility will be 20.1 miles, assuming a background of 40 miles. In the Bridger Wilderness Area, visibility is estimated to be 39.8 miles in 1985 for a reduction of less than 0.7% from the background. In the vicinity of Flaming Gorge National Recreational Area, visibilities of 39.4 miles are predicted (visibility degradation 1.5%). At Fossil Butte, the computed visibility and visibility degradation are 36.4 miles and 8.9%, respectively.

For 1990, in the vicinity of the proposed North Block and Twin Creek mines a visibility of 22.1 miles is predicted assuming a background of 40 miles. In the Bridger Wilderness Area a visibility of 39.9 miles is estimated. In the vicinity of Flaming Gorge National Recreational Area visibilities of 39.5 miles are predicted (visibility degradation 1.3%). At Fossil Butte, the computed visibility and visibility degradation are 37.2 miles and 7.1%, respectively.

RELATIONSHIP BETWEEN SHORT-TERM USE OF THE ENVIRONMENT AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY FOR THE REGION

Short-term use of the environment (mining operations) will produce impacts that include generation of fugitive dust and gaseous pollutants (from vehicles) and a reduction in visibility.

Since the land surface will be reclaimed after EOML and returned to an equivalent of the pre-existing vegetative cover and general contours, the air pollution caused by the mining operations will be primarily a short-term phenomenon because most air quality impacts will cease when active mining and reclamation are completed. Short-term air quality impacts include fugitive dust generated by the mining activities, particulate emissions associated with blasting and coal fires, and reductions in visibility.

Air pollution from vehicle exhausts and fugitive dust emissions from access roads after the completion of mining will depend on the subsequent use of the land. The long-term effects of increased urbanization and the associated future development of industrial sources, transportation modes, and power generation are difficult to determine. If the labor force remains in Wyoming after major coal mining operations are completed, urban pollution would not recede. Furthermore, re-employment might imply new sources of industrial emissions.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES FOR REGION

Most air quality impacts associated with the mining would be reversed when the land is reclaimed and returned to an equivalent of the pre-existing vegetative cover and general contours. The only long-term air quality impacts anticipated are those resulting from increased urbanization and continued use of unpaved access roads after the projects have been completed or halted.

Irreversible meteorological impacts are also anticipated. Local, insignificant changes in the microclimatology of the area would result from the redistribution of the surface material at the mines.* Changes in contours and surface characteristics would irreversibly alter the wind field and surface heating of the air. For example, the divergent or convergent patterns of the surface winds would change according to the changes in small-scale surface contours. Changes in the composition of topsoil and vegetation could alter the absorption and radiation of solar heat.

Irretrievable air quality impacts will occur. The loss of good air quality for the period of the project cannot be retrieved. During the life of the project, TSP standards may be exceeded and visibility reduced in the immediate vicinity of most of the mine sites. The loss of clean air with increased urbanization will be irretrievable.

*See Chapter 2 in the Regional Technical Report, available at the Rock Springs District BLM office.

AIR QUALITY ALTERNATIVES TO THE PROPOSED ACTION

This chapter investigates the impacts on TSP and gaseous pollutant concentrations as well as climatic and visibility effects resulting from two alternative levels of mining development in the ES region. The first alternative, the no action or low-level scenario, considers impacts associated with background and the operation of two private mines (Winton and Reliance) that are not active in 1980. Therefore, the impact results presented for the low-level scenario address analysis years 1985 and 1990. The second alternative, the high-level scenario, along with background levels, consists of the five proposed and two projected mines considered in Chapter 4, three existing leases without proposed mine plans, and three potential mining "areas of interest." The latter six mines are not operational in 1980; therefore, impact results for 1980 are equivalent to those presented in Chapter 4. Consequently, impacts associated with the high-level scenario in this chapter address analysis years 1985 and 1990. The locations of all of the mine sites are depicted in subsequent subsections.

Fugitive Dust Emission Factors and Modeling Techniques

The methodologies used to determine fugitive dust emissions emanating from the coal mines considered in the alternative scenarios, as well as meteorological data and modeling techniques, are equivalent to those presented in Chapter 4. Particulate emission rates, as well as the acres disturbed, used to determine the size of the area sources in ERTAQ are presented in Tables SC8-1 and SC8-2 for the three existing leases without proposed mine plans and the three potential mining areas of interest. These parameters for all other mines evaluated herein are presented in Tables SC4-2, SC4-3, and SC4-4. The Rock Springs meteorological data were employed for all mines located in Sweetwater County; Fort Bridger meteorological data were used for all mines located within Lincoln and Uinta Counties. Prior to evaluation of the predicted impacts attributable to the low and high level scenarios of mining development, the reader is reminded of the uncertainties inherent in the state-of-the-art fugitive dust emission and model prediction methodologies discussed in Chapter 4.

TABLE SC8-1

PARTICULATE EMISSION RATES BASED ON TOTAL COAL PRODUCTION FOR 1985 AND 1990

Projected Mines Map Reference Number (MRN)*	Emission Rate (tons per year)
8	83
9	79
10	225
11	56
12	147
13	91

*Refers to mine numbers indicated on Map SC8-1. Numbers 8 to 10 correspond to the three mine "areas of interest" and MRN-11 through MRN-13 correspond to the three existing leases without mine proposals. Throughout this report, these six mines will be referred to as MRN-8 through MRN-13.

TABLE SC8-2

ACRES DISTURBED EQUALS SIZE OF AREA SOURCE IN ERTAQ MODELING

	1985	1990
MRN-8	3,028	3,028
MRN-9	2,880	2,880
MRN-10	8,202	8,202
MRN-11	1,247	1,247
MRN-12	3,201	3,201
MRN-13	1,980	1,980

NOTE: The disturbed acreage for MRN-8 through MRN-13 is equated to the total mine acreage due to lack of data.

Low-Level Scenario

Model Predictions of Annual Average Impact on Suspended Particulate (SP) Concentrations

Map SC8-1 depicts the regional distribution of simulated annual average SP concentrations in 1985 and 1990 from mining operations alone within the low-level scenario. The two projected mines (Winton and Reliance) comprising the low-level scenario will not be operational in 1980, and estimated fugitive dust emission rates for both mines are identical for 1985 and 1990. The model results, therefore, represent the proportional contribution of mining activity to the levels specified in the standards. The model predictions are evaluated in accordance with PSD regulations since these apply to source-specific impact alone. An evaluation of the total (background plus mining) ambient levels of suspended particulates (TSP) is presented later in the "Cumulative Air Quality Impacts."

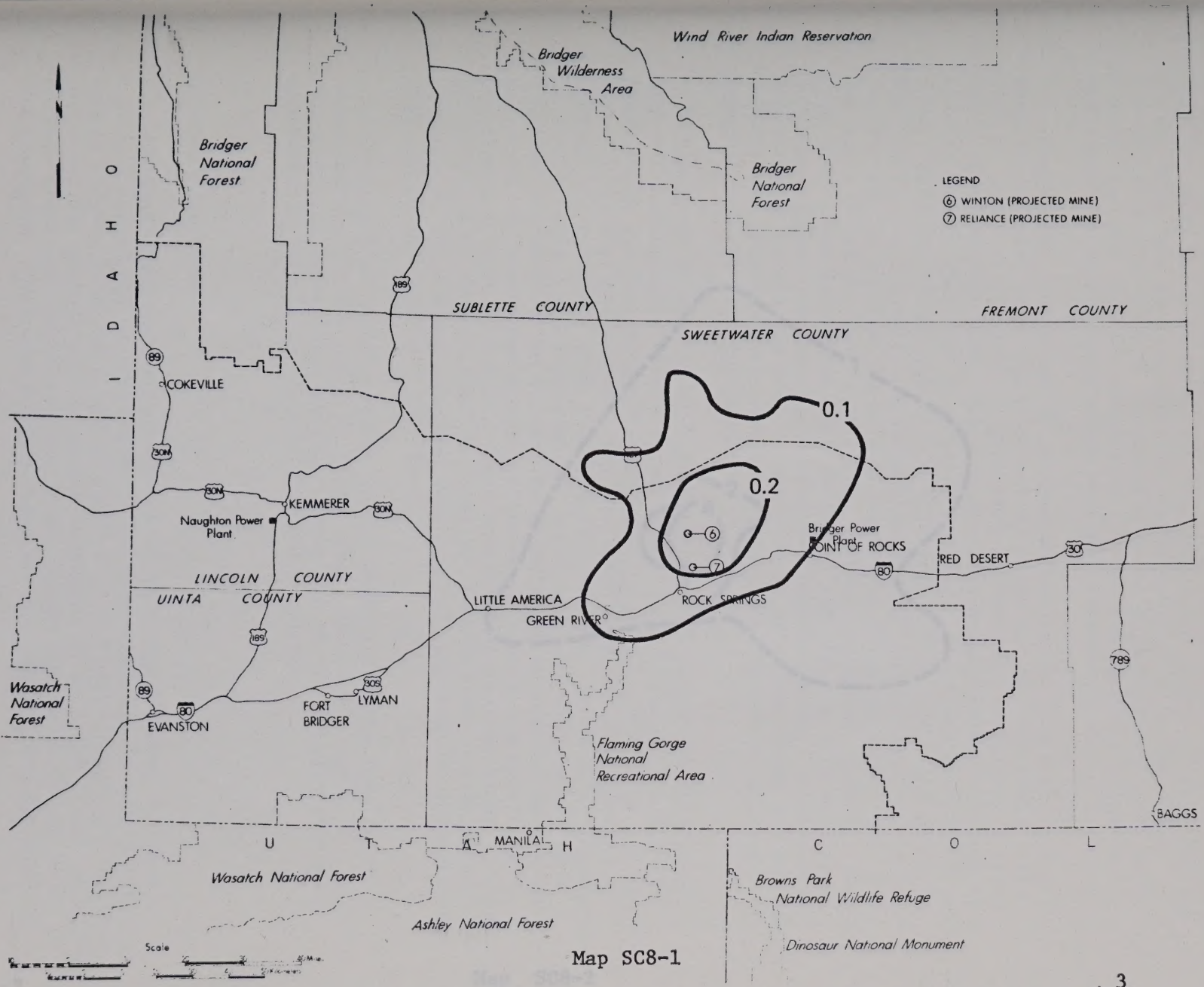
The highest predicted SP levels are less than 1 $\mu g/m^3$ and occur within a 6 mile radius of Winton. The Winton mine contributes approximately 92% to peak simulated levels of 0.6 $\mu g/m^3$; Reliance accounts for the remaining 8%. In general, dispersion of emissions from the Winton mine dominates predicted concentrations in this subregion since emissions from Winton are estimated to be more than 2.5 times greater than the emissions from Reliance. However, the Reliance mine does have a significant impact (greater than 50%) on receptors located within 3 miles of Reliance. Regionally, the impact associated with the low-level scenario is negligible, with no impact predicted outside of a 25 mile radius. The isopleths presented in Map SC8-1 are indicative of frequent southwesterly wind flow characterized by the Rock Springs meteorological data.

In accordance with the Clean Air Act Amendments of 1977 and corresponding PSD regulations, the entire ES region is designated Class II. The only exception is the Bridger Wilderness Area, which is a designated Class I area. Nonetheless, SP concentrations throughout the ES region are predicted to be lower than the allowable Class I 5 $\mu g/m^3$ increment.

The designated NA trona mining area is located approximately 6 miles north of Green River and 13 miles west of Winton and Reliance. Model simulations indicate no impact associated with the low-level scenario in this area.

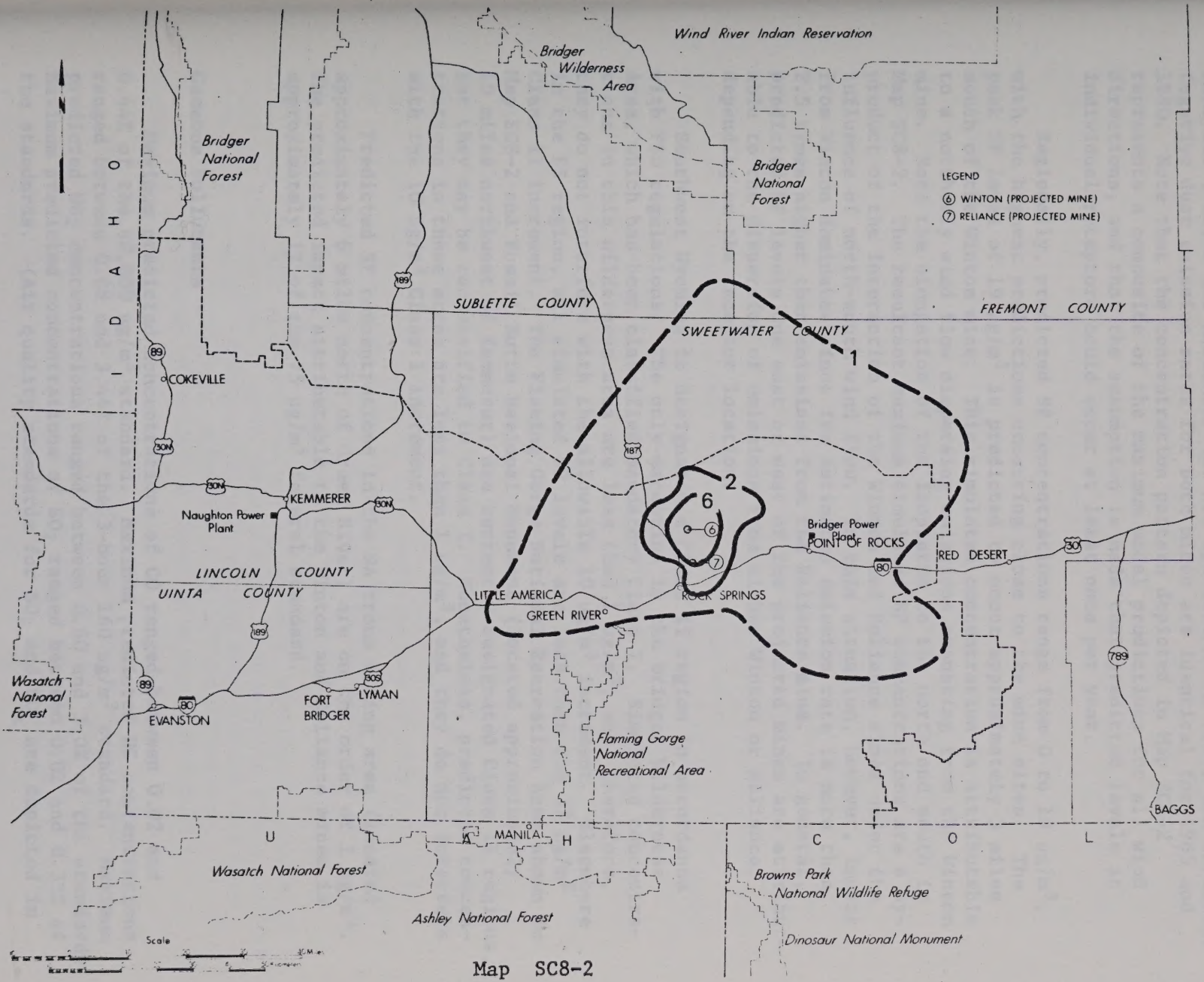
Model Predictions of 24-Hour Average Impact on SP Concentrations

The methodology used to determine worst-case 24-hour average impacts is equivalent to the technique described in Chapter 4. Map SC8-2 shows these worst-case predictions for 1985 and 1990 associated with the mines



Map SC8-1

Low-Level Scenario: 1985 and 1990 Predicted Annual Average SP Concentrations ($\mu g/m^3$) Attributable to Winton and Reliance Mines Alone



Map SC8-2

Low-Level Scenario: 1985 and 1990 24-Hour Average SP Concentrations ($\mu g/m^3$)
Attributable to Winton and Reliance Mines Alone

that constitute the low-level scenario. The mines considered in this analysis (Winton and Reliance) are not operational in 1980, and estimated fugutive dust emission rates for both mines are identical for 1985 and 1990. Note that the concentration pattern depicted in Map SC8-2 represents a composite of the maximum model predictions for all wind directions, and that the assumption is made that predicted levels at individual receptors could occur at least once per year.

Regionally, predicted SP concentrations range from 0 to 19 $\mu g/m^3$, with the highest predictions occurring close to the mine sites. The peak SP level of 19 $\mu g/m^3$ is predicted to occur approximately 3 miles south of the Winton mine. This simulated concentration is attributable to a northerly wind flow dispersing emissions emanating from the Winton mine. Note the elongation of the isopleths to the north and south in Map SC8-2. The resultant maximum simulated SP concentrations are a by-product of the interaction of the Winton and Reliance mines under the influence of north-south wind flow. In this situation, however, impact from Winton dominates since its estimated emission rate is more than 2.5 times higher than emissions from the Reliance mine. In general, predicted SP levels due east or west of the projected mines are attributable to the dispersion of emissions from either Winton or Reliance, depending on the receptor location.

Southwest Wyoming is designated a Class II region in accordance with PSD regulations. The only exception is the Bridger Wilderness Area, which has been classified mandatory Class I. Simulated concentrations in this wilderness area are less than 1 $\mu g/m^3$, and, therefore, they do not interfere with the allowable 10 $\mu g/m^3$ increment. Elsewhere in the ES region, all simulated SP levels are less than the 37 $\mu g/m^3$ Class II increment. The Flaming Gorge National Recreation Area shown in Map SC8-2 and Fossil Butte National Monument (located approximately 10 miles northwest of Kemmerer) are currently designated Class II regions, but they may be reclassified to Class I. Nonetheless, predicted concentrations in these areas are less than 1 $\mu g/m^3$, and they do not interfere with the 10 $\mu g/m^3$ Class I increment.

Predicted SP concentrations in the NA trona mining area (located approximately 6 miles north of Green River) are on the order of 1 $\mu g/m^3$. The predicted impact attributable to the Winton and Reliance mines is approximately 1% of the 75 $\mu g/m^3$ federal standard.

Gaseous Pollutants

Maximum predicted concentrations of CO ranged between 0.02 and 0.44% of the 40,000 $\mu g/m^3$ standard. Maximum predicted HC concentrations ranged between 0.88 and 3.44% of the 3-hour 160 $\mu g/m^3$ standard. Maximum predicted NO_2 concentrations ranged between 0.60 and 3.0% of the standards. Maximum predicted concentrations of SO_2 ranged between 0.02 and 0.33% of the standards. (Air quality standards for SO_2 and NO_x are depicted in

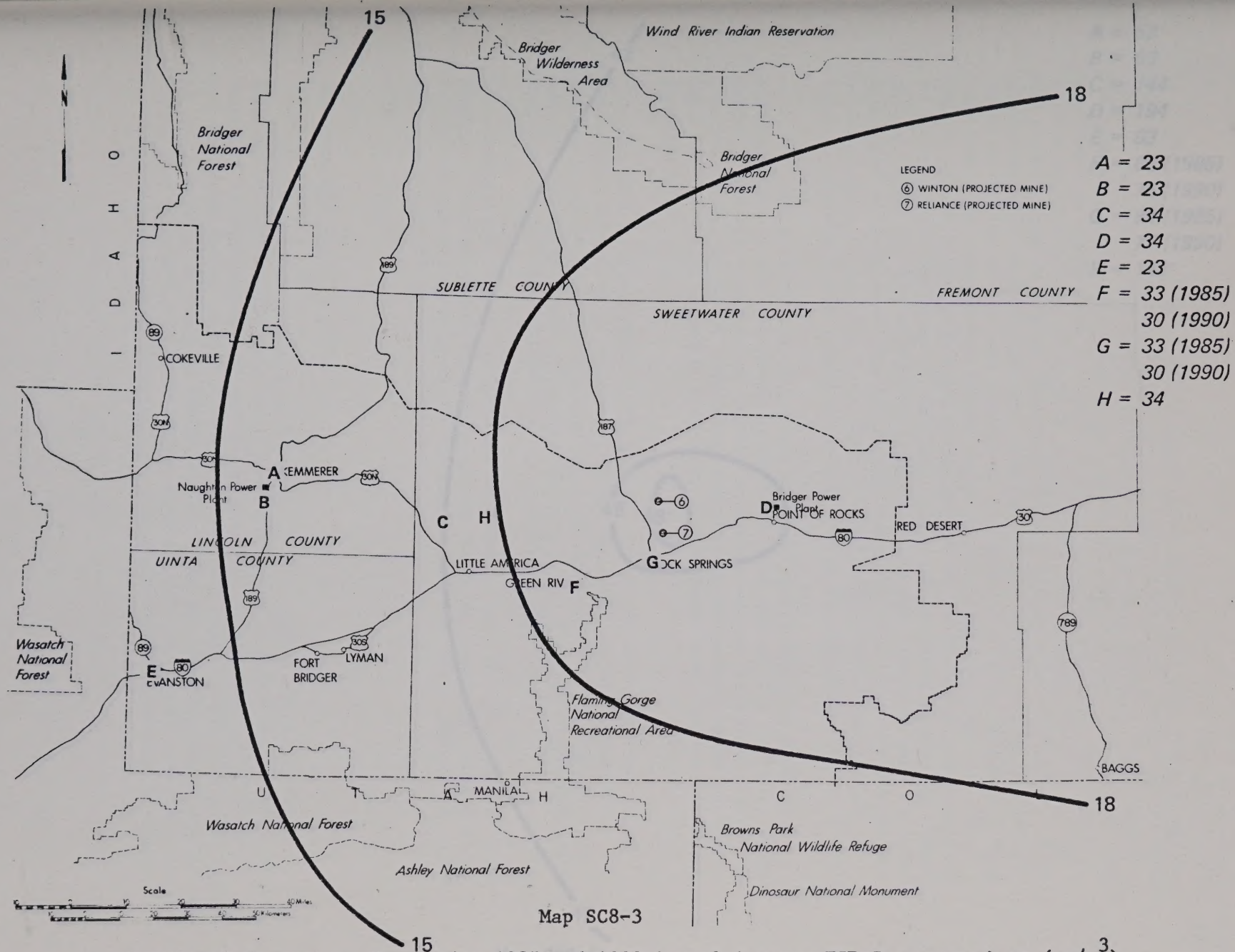
Chapter 4.) The values represent predictions at less than one-half mile from the mines. Predictions were significantly less at further distances from the mines. Assuming similar vehicle activity for all western coal mines, the regional cumulative impact of vehicle emissions on ambient concentrations of gaseous pollutants would be minimal and insignificant compared to their respective standards.

Cumulative Impacts on Air Quality

The cumulative TSP impacts presented in this section have been computed by adding predicted mine-related SP concentrations to projected background concentrations. In this study, background refers to the resultant SP concentrations attributable to the combined impacts of all sources in the ES region other than the mines that were modeled. Total suspended particulate levels (mine plus background) characterize predicted ambient air quality, and total concentrations may be compared to federal and Wyoming ambient air quality standards. Background-related SP concentrations to be added to the mine simulations for each analysis year are presented in Chapter 4 (Table SC4-10). Note that these levels are categorized as rural, industrial, or urban background within each county in the ES region. Similar to Chapter 4, the mid-points of the background ranges were graphically combined with mine impact simulations for a pictorial representation of cumulative impacts. Use of these background range mid-points is purely arbitrary and applied for illustrative purposes only. These simulated annual and 24-hour average cumulative TSP impacts are presented in Maps SC8-3 and SC8-4, respectively.

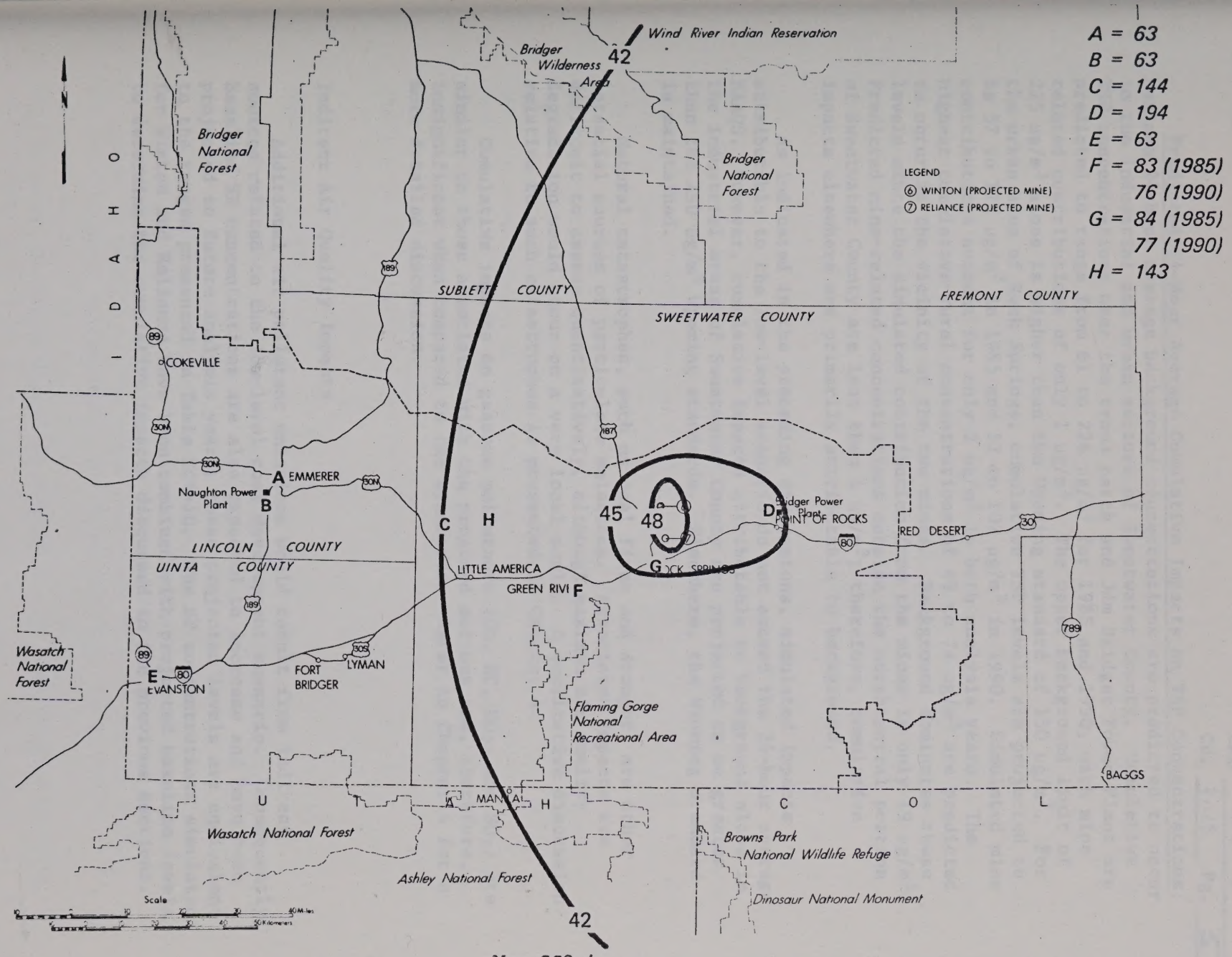
Predicted Annual Average Cumulative Impacts on TSP Concentrations. The highest background concentrations are projected to be in the industrial and urban sectors of Sweetwater County for 1985 and 1990. Cumulative TSP levels in the vicinities of the trona patch and Jim Bridger Power Plant consist of simulated mine contributions of only 0.1 $\mu g/m^3$ and background levels of 23 to 45 $\mu g/m^3$. Background also dominates the cumulative values near Rock Springs, where the two mines are projected to contribute 0.2 $\mu g/m^3$, and background contributes 28 to 38 $\mu g/m^3$ in 1985 and 25 to 35 $\mu g/m^3$ in 1990. Peak rural cumulative levels are predicted to occur near the mine sites. However, simulated mine concentrations are less than 1 $\mu g/m^3$, which result in cumulative levels ranging from 14 to 24 $\mu g/m^3$. Outside a 25 mile radius from the two projected mines, there is no simulated mine impact on TSP concentrations. Therefore, cumulative TSP levels in these areas are represented by background alone.

Cumulative TSP concentrations are predicted to be less than the Wyoming 60 $\mu g/m^3$ and federal 75 $\mu g/m^3$ standards throughout the ES region. From the preceding discussion, it is evident that background levels heavily dominate simulated cumulative impacts associated with the low-level scenario.



Map SC8-3

Low-Level Scenario: Cumulative 1985 and 1990 Annual Average TSP Concentrations ($\mu g/m^3$)



Map SC8-4

Low-Level Scenario: Cumulative 1985 and 1990 Predicted 24-Hour Average TSP Concentrations ($\mu g/m^3$)

Predicted 24-Hour Average Cumulative Impacts on TSP Concentrations. Maximum 24-hour average background concentrations are predicted to occur in the industrial and urban sectors of Sweetwater County. Cumulative TSP concentrations near the trona patch and Jim Bridger Power Plant are predicted to range from 61 to 226 $\mu g/m^3$ for 1985 and 1990, with mine related contributions of only 1 $\mu g/m^3$. The upper background limit of 225 $\mu g/m^3$ alone is higher than the Wyoming standard of 150 $\mu g/m^3$. For the urban area of Rock Springs, cumulative TSP levels are projected to be 57 to 112 $\mu g/m^3$ in 1985 and 52 to 102 $\mu g/m^3$ in 1990. Simulated mine contributions account for only 2 $\mu g/m^3$ in both analysis years. The highest cumulative rural concentrations of 49 to 74 $\mu g/m^3$ are predicted to occur in the vicinity of the two mines. Background dominates these levels since the simulated contribution from the mines is only 19 $\mu g/m^3$. Predicted mine-related concentrations outside the northcentral portion of Sweetwater County are less than 1 $\mu g/m^3$; therefore, cumulative impacts elsewhere are primarily attributable to background.

As indicated in the preceding discussions, simulated impacts attributable to the low-level scenario do not exceed the 24-hour average NAAQS. However, cumulative impacts attributable to background alone in the industrial areas of Sweetwater County are projected to be greater than the 150 $\mu g/m^3$ Wyoming standards. Elsewhere, the Wyoming standard is maintained.

Natural catastrophes, such as coal fires and drought, are other potential sources of particulate emissions. Associated impacts are difficult to assess quantitatively, although maximum air quality degradation would occur on a very local scale. A qualitative discussion relative to such catastrophes is presented in Chapter 4.

Cumulative impacts on gaseous pollutants (CO, HC, NO_2, and SO_2) are similar to those associated with the proposed actions and, therefore, insignificant when compared to the standards. Refer to Chapter 4 for a more detailed discussion.

Indirect Air Quality Impacts

Additional air pollutant emissions would result from indirect sources related to the low-level coal development scenario. Consequently, baseline SP concentrations are also expected to increase and have been projected to future analysis years; these projected levels are equivalent to the ranges presented in Table SC4-10. The SP concentrations simulated for Winton and Reliance have been combined with projected baseline levels to determine the cumulative impacts discussed in the previous sections.

Quantitative indirect source impacts on variations in baseline SO_2 and NO_x concentrations are unknown (see Chapter 2 Regional Technical Report).* However, the contributions from the mines are expected to be negligible.

Probable Cumulative Impacts

A brief enumeration on the transport of aerosols and their possible effects on climate is presented in the Chapter 2 Regional Technical Report. However, the available data do not provide a firm basis for conclusive statements about what role low-level mining activities would play in altering the ES region's existing climate over the next fifteen years.

Visibility

The methodology used to evaluate the impact of the low-level scenario on visibility is identical to the technique described in Chapter 4. Regional background visibilities are assumed to be 40 miles for each year based on current visibility observations and evaluation of projected regional background SP values.

For the low-level scenario, the worst-case, 24-hour SP concentrations attain values as high as 19 $\mu g/m^3$ in the vicinity of the projected Winton and Reliance mines. This corresponds to a visibility of 37.8 miles, assuming a background of 40 miles. Most of the region, however, is associated with simulated levels less than 10 $\mu g/m^3$, which corresponds to a visibility of 38.8 miles, or a reduction of 1.2 miles from the background. Concentrations in the Bridger Wilderness Area (Class I) and in the Flaming Gorge Recreational Area are less than 0.3 $\mu g/m^3$, and impact on visibility degradation is negligible.

High-Level Scenario

Model Predictions of Annual Average Impact on SP Concentrations for 1985 and 1990

Maps SC8-5 and SC8-6 present the regional distributions of annual average SP concentrations for 1985 and 1990 from the mining operations alone. As discussed earlier, 1980 impacts are equivalent to those presented in Chapter 4. The mines considered in this chapter include the five proposed action mines, the three existing leases without

*The Regional Technical Report is located in the Rock Springs District BLM Office.

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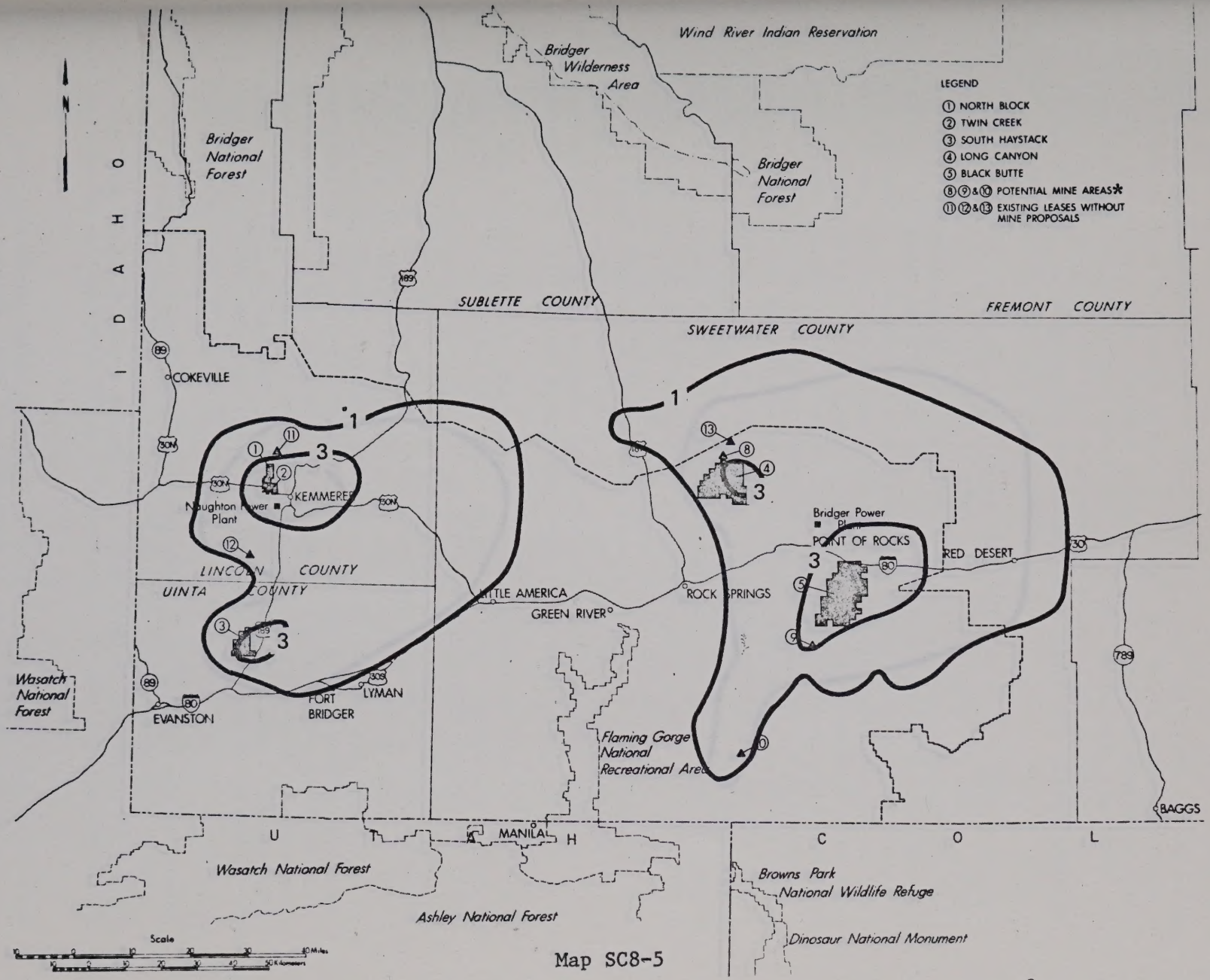

Map SC8-5

High-Level Scenario: 1985 Predicted Annual Average SP Concentrations ($\mu g/m^3$)
Attributable to the Mines Alone

*Equivalent to "mine areas of interest,"

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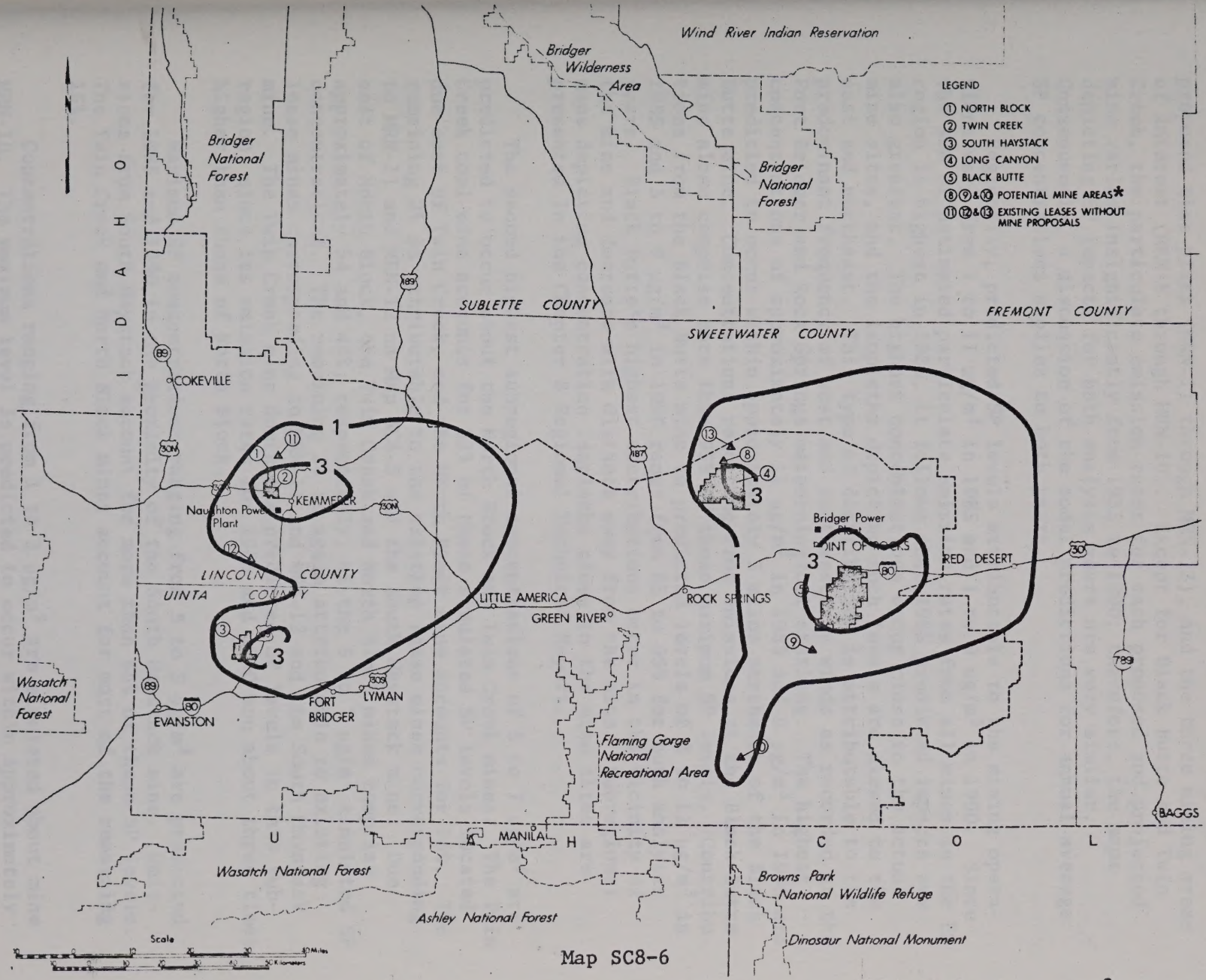

Map SC8-6

High-Level Scenario: 1990 Predicted Annual Average SP Concentrations ($\mu g/m^3$) Attributable to the Mines Alone

*Equivalent to "mine areas of interest."

proposed mine plans (MRN-11 through MRN-13), and the three mining areas of interest (MRN-8 through MRN-10). Except for Black Butte and Twin Creek, the particulate emission rates for each proposed and projected mine varies insignificantly from 1985 to 1990; therefore, the maps depicting SP impacts for both analysis years are very similar. Consequently, a discussion of the model predictions for annual average SP concentrations applies to both years.

Regionally, predicted SP levels attributable to the mining operations vary from 1 to 11 $\mu g/m^3$ in 1985 and 1 to 9 $\mu g/m^3$ in 1990. Since the sum of estimated particulate emission rates from all mines in the ES region is highest in 1985, it follows that 1985 predicted impacts are also greatest. The highest concentrations occur close to the actual mine sites, and the isopleths depicting such levels are skewed to the east and northeast. This type of distribution is attributable to the predominant frequency of west and southwesterly winds as recorded at the Fort Bridger and Rock Springs meteorological stations. The highest concentrations of approximately 11 $\mu g/m^3$ in 1985 and 9 $\mu g/m^3$ in 1990 are predicted to occur within approximately 3 miles northeast of the Black Butte mine. Concentrations resulting from emissions at the Black Butte mine alone comprise more than 95% of these maximum SP levels. Contributions from the Black Butte mine to predicted levels of 3 to 11 $\mu g/m^3$ in 1985 and 3 to 9 $\mu g/m^3$ in 1990 range from 85 to 95% for both analysis years. Black Butte's highest contributions occur in the vicinity of the mine and decrease with distance away from the mine. Subregional maps depicting concentration isopleths close to the mine sites are presented in the Chapter 8 Regional Technical Report.

The second highest subregional concentrations of 5 to 7 $\mu g/m^3$ are predicted to occur about the North Block and Twin Creek mines. The Twin Creek coal mine accounts for 82% of these simulated SP levels located due east of Twin Creek, and the North Block mine accounts for 16%. The remaining 2% is attributable to the existing lease mines corresponding to MRN-11 and MRN-12 on Map SC8-5 and the South Haystack mine. Due east of North Block, the Twin Creek and North Block mines comprise approximately 54 and 44%, respectively, of the 5 to 7 $\mu g/m^3$ simulated SP concentrations. The remaining 2% is again attributable to existing lease mines corresponding to MRN-11 and MRN-12 and the South Haystack mine. The Twin Creek mine dominates predicted SP levels in this subregion, since its emission rates for 1985 and 1990 are about three times higher than those of North Block.

Maximum SP concentrations ranging from 3 to 5 $\mu g/m^3$ are predicted for 1985 and 1990 in the proximity of the South Haystack mine. Emissions from South Haystack account for more than 85% of these SP levels. The Twin Creek and North Block mines account for most of the remaining 15%.

Concentrations ranging from 1 to 3 $\mu g/m^3$ are simulated about mine MRN-10. The maximum level is predicted to occur within approximately

2 miles of this mining area of interest; 78% of these levels are due to MRN-10, and 13% are due to the Black Butte mine.

The Long Canyon subregional area exhibits small predicted impact with peak SP levels of 3 $\mu g/m^3$. Such levels are attributable to several active coal mines in the area. The Long Canyon mine contributes approximately 45% to the 3 $\mu g/m^3$ levels; while Black Butte, MRN-8, and Twin Creek comprise approximately 18, 14, and 8%, respectively. The remaining 10% is attributable to a combination of lesser contributions from the other mines.

All applicable PSD restrictions are met by the predicted annual average SP concentrations for the high-level scenario in 1985 and 1990. Predicted SP levels in the Class I Bridger Wilderness Area are less than 1 $\mu g/m^3$, which complies with the 5 $\mu g/m^3$ increment. Elsewhere in the Class II designated areas, maximum SP concentrations of 11 $\mu g/m^3$ are predicted to occur in the vicinity of the Black Butte mine. However, these peak SP levels are less than the 19 $\mu g/m^3$ Class II increment.

The Flaming Gorge Recreational Area shown in Maps SC8-5 and SC8-6 and the Fossil Butte National Monument located approximately 10 miles northwest of Kemmerer are currently designated Class II areas but may be reclassified to Class I. However, predicted SP concentrations in these areas are approximately 1 $\mu g/m^3$ in 1985 and 1990, well below the Class I 5 $\mu g/m^3$ increment.

Annual average SP concentrations of less than 1 $\mu g/m^3$ in 1985 and 1990 are predicted to occur in the vicinity of the NA trona patch, located 6 miles north of Green River. The predicted mine impact is less than 1% of the 260 $\mu g/m^3$ federal standard.

Model Predictions of 24-Hour Average Impact on SP Concentrations for 1985

Predicted SP impact from the high level of mining development alone is depicted in Maps SC8-7 and SC8-8. Note that the concentration pattern depicted in the maps represents a composite of the maximum model predictions for all wind directions and that the assumption is made that predicted levels at individual receptors could occur at least once per year. Regionally, simulated SP levels range from 5 to 120 $\mu g/m^3$, although somewhat higher concentrations are predicted to occur within 2 miles south of the Twin Creek mine. In the eastern portion of the ES region, estimated emissions emanating from the Black Butte mine dominate predicted impact. Although several underground mines in this area are operational in 1985, the sum of their emission rates is less than 15% of the Black Butte mine emission rate. Therefore, the skewing effect illustrated by the isopleths is associated, in general, with the wind direction that lines up the Black Butte mine with a given receptor. The other mines in this area do influence concentrations predicted very

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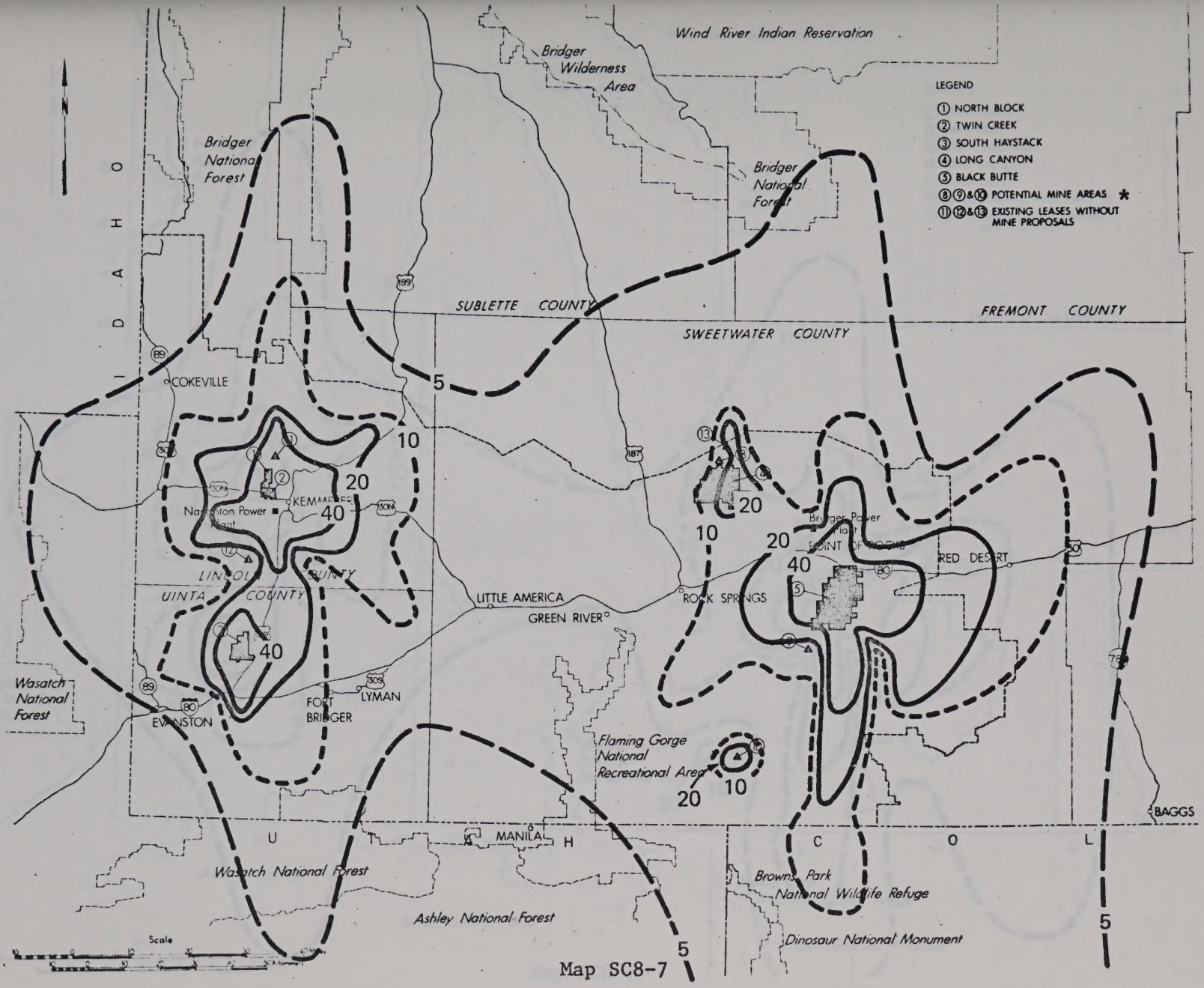
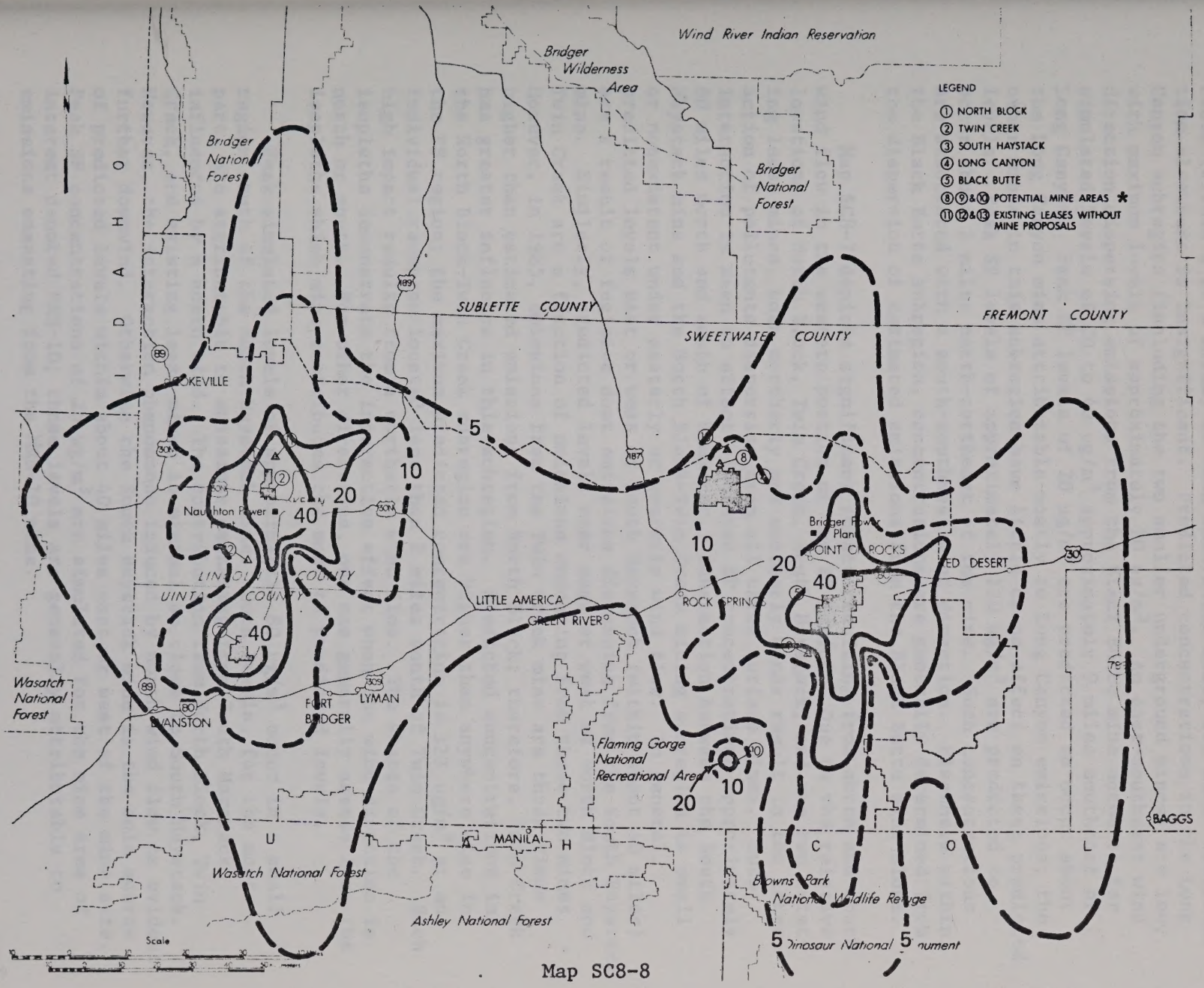


High-Level Scenario: 1985 Predicted 24-Hour Average SP Concentrations ($\mu g/m^3$)
Attributable to the Mines Alone

*Equivalent to"mine areas of interest,"



Map SC8-8

High-Level Scenario: 1990 Predicted 24-Hour Average SP Concentrations ($\mu g/m^3$)
Attributable to the Mines Alone

*Equivalent to "mine areas of interest."

close (within 3 to 5 miles) to each individual mine, but their contribution elsewhere is insignificant. Predicted concentrations in the Long Canyon subregion (including the two smaller underground mines) are low, with maximum levels of approximately 20 $\mu g/m^3$. An east-southeast wind direction dispersing emissions from the Black Butte mine accounts for simulated levels of 20 to 40 $\mu g/m^3$ approximately 9 miles southeast of Long Canyon. Peak SP levels of 20 $\mu g/m^3$ are predicted to occur about the Long Canyon mine attributable mostly to Long Canyon emissions; the other mines in this subregion have little or no effect on these predicted levels. Peak SP levels of approximately 120 $\mu g/m^3$ are predicted to occur about 2 miles north-northeast of the mine. Such concentrations are associated with a south-southwest wind direction. Elsewhere within the Black Butte subregion, concentrations are generally determined from the dispersion of estimated emissions from the Black Butte mine alone.

Map SC8-7 depicts significant impact resulting from north and south wind flow in the western portion of the ES region. Due to the relative locations of North Block, Twin Creek, South Haystack, and the two existing lease mines, both northerly and southerly winds result in the interaction of pollutants dispersing from all three surface mines. Such interaction is seen to affect simulated SP concentrations approximately 60 miles north and south of Kemmerer. Interaction between the South Haystack mine and the North Block-Twin Creek mining subregion is small or nonexistent under easterly or westerly wind flow. In general, predicted levels east or west of South Haystack (within about 40 miles) are a result of fugitive dust emissions dispersing from the South Haystack mine. Similarly, predicted levels near east or west of North Block and Twin Creek are a function of emissions emanating from these two mines. However, in 1985, emissions from the Twin Creek mine are three times higher than estimated emissions from North Block; therefore, Twin Creek has greater influence in this subregion. Predicted concentrations in the North Block-Twin Creek subregion are higher than anywhere else in the ES region; the maximum predicted concentration is 323 $\mu g/m^3$ at an individual receptor located less than 2 miles south of Twin Creek. Such high impact results from a northerly wind flow. The shapes of the isopleths demonstrate the interactive effect when the wind direction is north or south. For other directions, one can generally assess from the isopleths which mine contributes the most to predicted levels.

Peak simulated levels of approximately 80 $\mu g/m^3$ occur in a small region south of the South Haystack mine. Such levels, for the most part, are attributable to emissions emanating from South Haystack influenced by a north wind. The contribution from North Block, Twin Creek, and existing lease mines is minimal so close to South Haystack. However, the interaction phenomenon induced by north wind flow is evident further downwind. Otherwise the South Haystack mine is the sole source of predicted levels within about 40 miles east or west of the mine site. Peak SP concentrations of 25 $\mu g/m^3$ are simulated for the mine area of interest denoted MRN-10; these levels are generally attributable to emissions emanating from the MRN-10 mine.

Mining areas of interest and existing lease mines corresponding to MRN-8 through MRN-13 on Map SC8-7 have an insignificant contribution to 24-hour average concentrations on a regional scale due to their low emission rates as depicted in Table SC8-1. Therefore, regionally predicted SP concentrations for the high-level scenario hardly differ from the levels simulated for the most probable level of mining development discussed in Chapter 4.

For PSD increments, simulated concentrations in the Bridger Wilderness Area are less than 2 $\mu g/m^3$, which does not interfere with the 10 $\mu g/m^3$ Class I increment. The remaining portion of southwest Wyoming is designated Class II. The 37 $\mu g/m^3$ allowable PSD increment is exceeded in the vicinity of all the mine sites except that of Long Canyon, which is an underground mine.

At the present time, both the Flaming Gorge National Recreation Area and Fossil Butte National Monument are Class II regions but have the potential to be redesignated to Class I. Predicted worst-case 24-hour average concentrations at Flaming Gorge are approximately 5 $\mu g/m^3$ or less than the 10 $\mu g/m^3$ Class I increment. However, at the Fossil Butte National Monument, simulated SP levels are on the order of 20 $\mu g/m^3$, which exceeds the Class I increment but does not exceed the allowable Class II increment of 37 $\mu g/m^3$.

The area located 6 miles north of Green River is designated an NA area. Simulated SP impact for this region is approximately 7 $\mu g/m^3$, which is less than 3% of the 260 $\mu g/m^3$ federal standard.

Model Predictions of 24-Hour Average Impact on SP Concentrations for 1990

The predicted impacts from the high-level scenario in 1990 are presented in Map SC8-8. Regionally, simulated SP concentrations range from 5 to approximately 120 $\mu g/m^3$; the highest impacts are predicted to occur in the near vicinity of the mine sites. In the Rock Springs area, worst-case predicted SP levels are generally determined from fugitive dust emissions at Black Butte. Similar to 1985, emissions from Black Butte are more than three times higher than the sum of emissions from the several underground mines in the vicinity of Rock Springs. Consequently, dispersion of emissions from the Black Butte mine determine the elongated portions of the isopleths presented in Map SC8-8. That is, the skewing effect is a result of the wind direction lining up the Black Butte mine with such receptors. The only significant influence resulting from Long Canyon emissions is to receptors located very close (within 3 to 5 miles) to the Long Canyon mine. Mines MRN-8 through MRN-10 and MRN-13 with such low fugitive dust emission rates have an insignificant contribution to simulated concentrations in the eastern portion of the ES region. Peak concentrations of approximately 20 $\mu g/m^3$

are predicted to occur about the Long Canyon mine. These concentrations result from a northerly wind flow dispersing emissions from Long Canyon. SP concentrations of 20 $\mu g/m^3$ are also predicted to occur 12 miles southeast of Long Canyon. These predicted levels are attributable to the Black Butte mine influenced by an east-southeast wind direction. Maximum SP levels of 120 $\mu g/m^3$ are predicted to occur within 2 miles northeast of the Black Butte mine; these levels are associated with winds from the west-southwest. Elsewhere within the Black Butte subregion, predicted concentrations are generally dominated by dispersion of Black Butte's fugitive dust emissions.

In the western half of the ES region, Map SC8-8 indicates significant impact resulting from north and south wind flow. Because of the relative locations of North Block, Twin Creek, South Haystack, and existing lease mines, both northerly and southerly winds result in the interaction of pollutants dispersing from all three surface mines. Such interaction is seen to affect simulated SP concentrations approximately 60 miles north and south of Kemmerer. Interaction between the South Haystack mine and the North Block-Twin Creek mining subregion is small or nonexistent under easterly or westerly wind flow. In general, predicted levels east or west of South Haystack (within about 40 miles) are dominated by fugitive dust emissions dispersing from the South Haystack mine. Similarly, predicted levels near east or west of North Block and Twin Creek are a function of emissions emanating from these two mines. However, in 1990, emissions from the Twin Creek mine are almost three times higher than estimated emissions from North Block; therefore, Twin Creek has greater influence in this subregion. Maximum predicted SP concentrations in the North Block-Twin Creek subregion are greater than 120 $\mu g/m^3$. The peak predicted concentration located approximately 2 miles south of Twin Creek is 264 $\mu g/m^3$. Note that emissions from both the Twin Creek and North Block mines decrease from 1985 to 1990 by approximately 17%. The shapes of the isopleths portray the interactive effect between the mines during northerly and southerly wind flow. Because of its high emission rate, the Twin Creek mine dominates predicted concentrations in this subregion.

Predicted SP levels about the South Haystack mine range from 20 to 80 $\mu g/m^3$. Again, interaction between mines is apparent with north and south wind directions. However, within approximately 3 miles of the mine, the major portion of simulated concentrations are attributable to South Haystack. This is the case in all subregions; the interactive effect between mines is not significant at receptors located close to the mine site. Peak SP concentrations of approximately 25 $\mu g/m^3$ are predicted to occur about mine MRN-10. These simulated levels are attributable primarily to MRN-10 alone. Note that predicted concentrations northeast of the mine are slightly lower than the 1985 simulations; this is due to a decrease in emissions from the Black Butte mine from 1985 to 1990 (see Tables SC4-2 and SC4-3).

Mining areas of interest and existing lease mines corresponding to MRN-8 through MRN-13 on Map SC8-8 have an insignificant contribution to 24-hour average concentrations on a regional scale due to their low emission rates as depicted in Table SC8-1. Therefore, regionally predicted SP concentrations for the high-level scenario hardly differ from the levels simulated for the most probable level of mining development discussed in Chapter 4.

Concentrations of suspended particulates predicted to occur throughout the Class I Bridger Wilderness Area are on the order of 1 $\mu g/m^3$, which is well below the 10 $\mu g/m^3$ allowable PSD increment. The allowable PSD increment for the rest of southwest Wyoming (designated Class II) is maintained regionally except in the vicinity of some of the surface mines as depicted in Map SC8-8.

The Flaming Gorge Recreational Area shown on Map SC8-8 and the Fossil Butte National Monument (located approximately 10 miles northwest of Kemmerer) are currently Class II regions but may be redesignated to Class I. Concentrations of suspended particulates less than 5 $\mu g/m^3$ are predicted to occur throughout the Flaming Gorge Area, which complies with the Class I 10 $\mu g/m^3$ increment. Predicted levels at Fossil Butte are approximately 20 $\mu g/m^3$, which complies with the Class II increment but exceeds the allowable Class I increment.

Impact from the high level of mining development in 1990 is indicated for the NA trona patch, located 6 miles north of Green River. As indicated in Map SC8-8, predicted concentrations in this area are on the order of 5 $\mu g/m^3$, which is less than 2% of the federal 260 $\mu g/m^3$ standard.

Gaseous Pollutants

Maximum predicted concentrations of CO ranged between 0.02 and 0.44% of the 40,000 $\mu g/m^3$ standard. Maximum predicted HC concentrations ranged between 0.88 and 3.44% of the 3-hour 160 $\mu g/m^3$ standard. Maximum predicted NO_2 concentrations ranged between 0.60 and 3.0% of the standards. Maximum predicted concentrations of SO_2 ranged between 0.02 and 0.33% of the standards. (Air quality standards for SO_2 and NO_x are depicted in Chapter 4.)

The values represent predictions at less than one-half mile from the mines. Predictions were significantly less at further distances from the mines. Assuming similar vehicle activity for all western coal mines, the regional cumulative impact of vehicle emissions on ambient concentrations of gaseous pollutants would be minimal and insignificant compared to their respective standards.

Cumulative Impacts on Air Quality

This section presents a discussion of cumulative impacts on TSP levels in the ES region, i.e., the summation of predicted SP concentrations attributable to the mines discussed in the previous sections in combination with Winton and Reliance and projected background concentrations. Winton and Reliance were modeled as in the low-level scenario and predicted impacts were determined. A more comprehensive discussion of the background as well as a quantitative range of background levels throughout the ES region is presented in Chapter 4. Similar to Chapter 4, the mid-points of the background ranges were graphically combined with mine impact simulations for a pictorial representation of cumulative impacts. Use of these background range mid-points is arbitrary and applied for illustrative purposes only; the reader can just as easily choose any point within the projected ranges to determine cumulative impacts. These simulated 1985 and 1990 annual and 24-hour average cumulative TSP impacts are presented in Maps SC8-9 through SC8-12, respectively.

Model Predictions of Annual Average Cumulative Impacts on TSP Concentrations. The highest background levels are projected to occur within the industrial and urban areas of Sweetwater County. When combined with simulated mine concentrations, cumulative levels for 1985 and 1990 are predicted to range from 24 to 46 $\mu g/m^3$ in the vicinity of the Jim Bridger Power Plant and the trona patch; predicted mine contributions to these levels are approximately 1 $\mu g/m^3$. Cumulative TSP concentrations in the vicinity of Rock Springs are predicted to range from 29 to 39 $\mu g/m^3$ in 1985 and 26 to 36 $\mu g/m^3$ in 1990. Again, simulated mine contributions to these totals are approximately 1 $\mu g/m^3$. In the proximity of Kemmerer, the mines are predicted to contribute 7 $\mu g/m^3$ and 6 $\mu g/m^3$ to ambient TSP levels in 1985 and 1990, respectively. When combined with background, cumulative TSP levels range from 25 to 35 $\mu g/m^3$ in 1985 and 24 to 34 $\mu g/m^3$ in 1990. Background alone accounts for 80% of such predicted levels. Close to the Black Butte mine where simulated mine TSP levels are the highest, cumulative concentrations range from 24 to 34 $\mu g/m^3$ in 1985 and 22 to 32 $\mu g/m^3$ in 1990. Background alone accounts for more than 50% of these levels; the remainder is primarily attributable to Black Butte. Within approximately 6 miles east of the North Block and Twin Creek mines, maximum predicted cumulative levels range from 17 to 27 $\mu g/m^3$ in both analysis years. Background accounts for more than 60% of this total; the North Block and Twin Creek mines dominate the mine contributions.

Near the South Haystack mine, predicted cumulative TSP levels range from 15 to 25 $\mu g/m^3$ for both analysis years. South Haystack alone accounts for one-third of these concentrations; the rest is attributable to background.

Simulated mine concentrations are lowest about the Long Canyon and MRN-10 subregions. When combined with projected background for 1985 and

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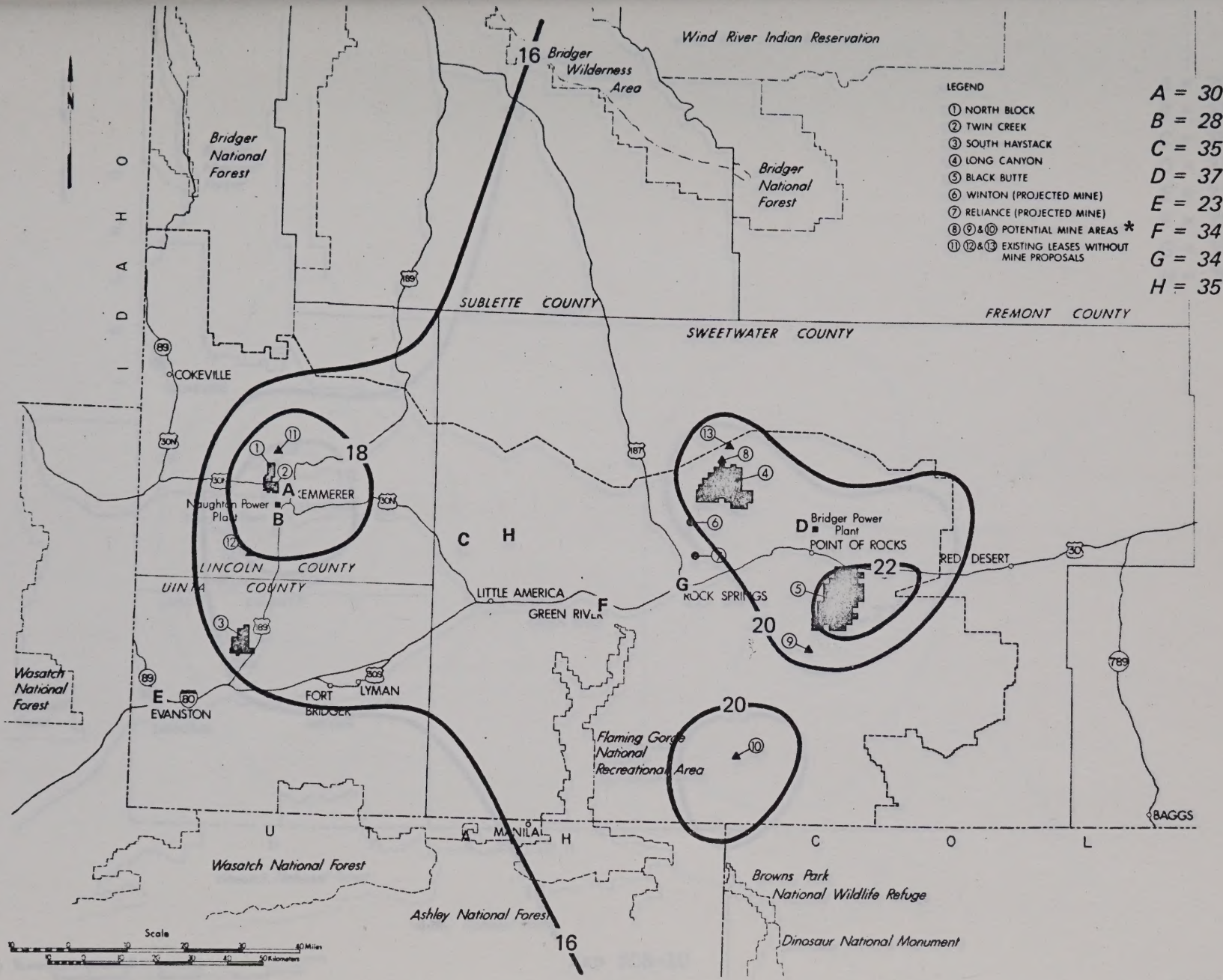

Map SC8-9

High-Level Scenario: Cumulative 1985 Predicted Annual Average TSP Concentrations ($\mu g/m^3$)

*Equivalent to "mine areas of interest."

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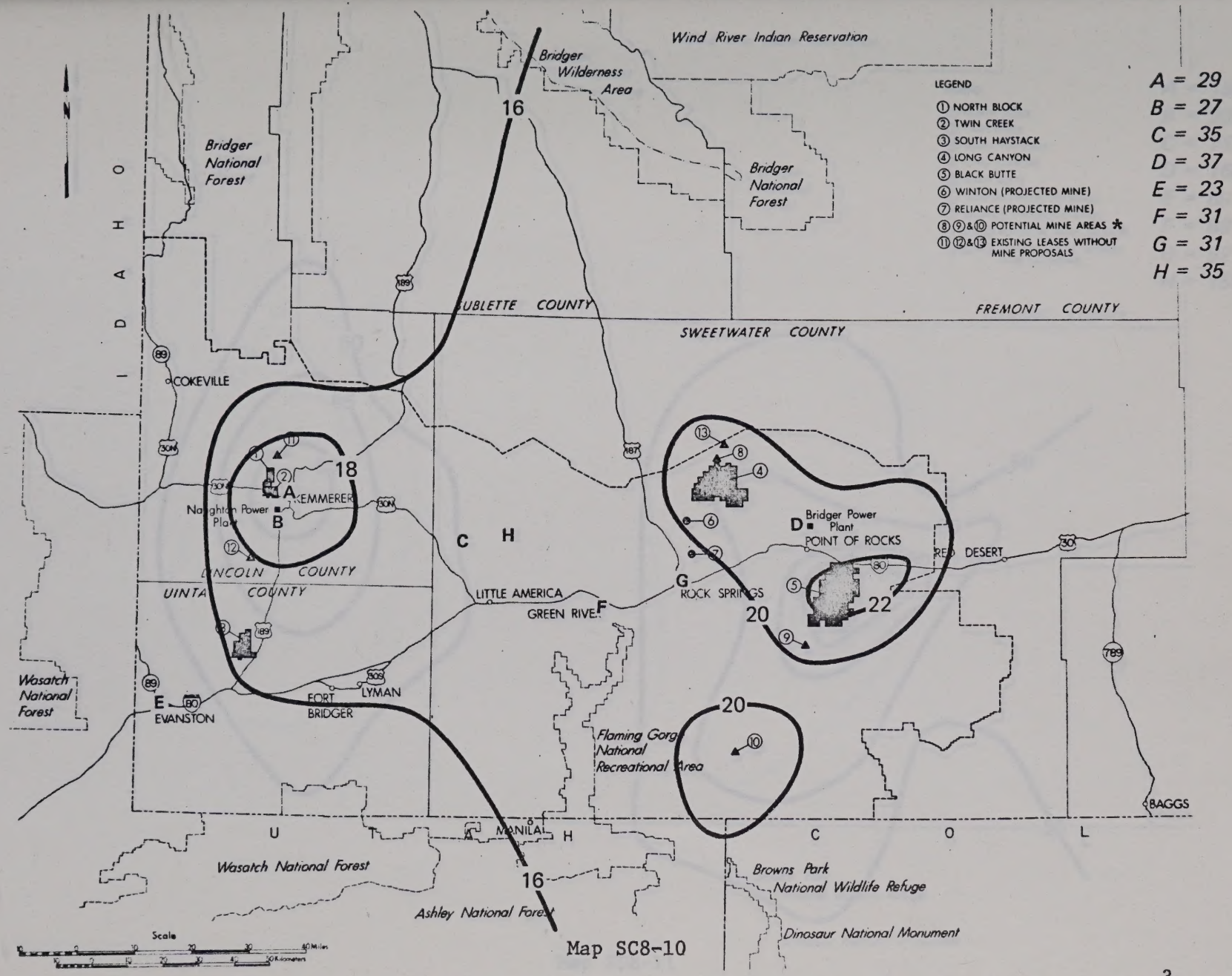

Map SC8-10

High-Level Scenario: Cumulative 1990 Predicted Annual Average TSP Concentrations ($\mu g/m^3$)

*Equivalent to "mine areas of interest."

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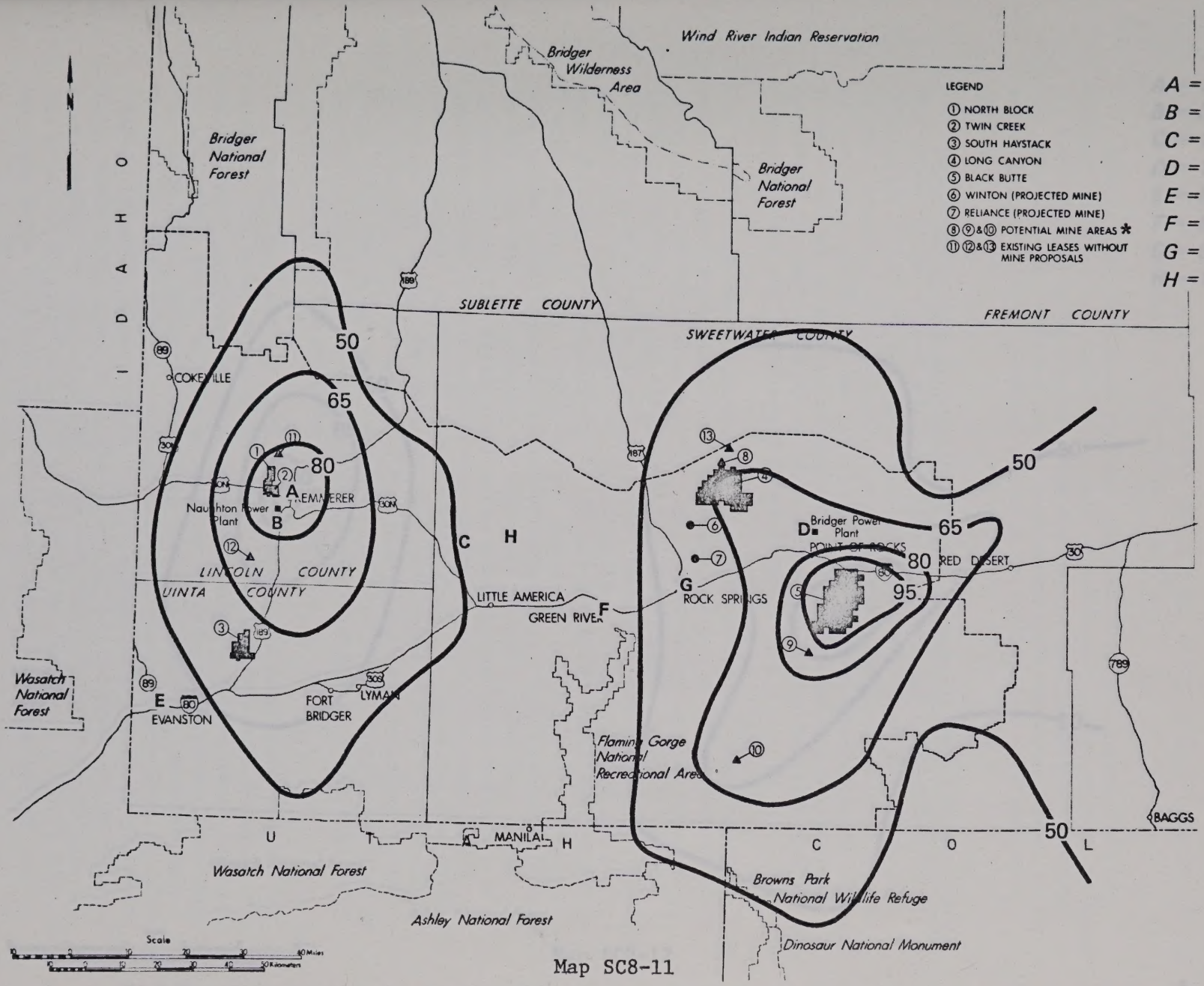

Map SC8-11

High-Level Scenario: Cumulative 1985 Predicted 24-Hour Average TSP Concentrations ($\mu g/m^3$)

*Equivalent to "mine areas of interest,"

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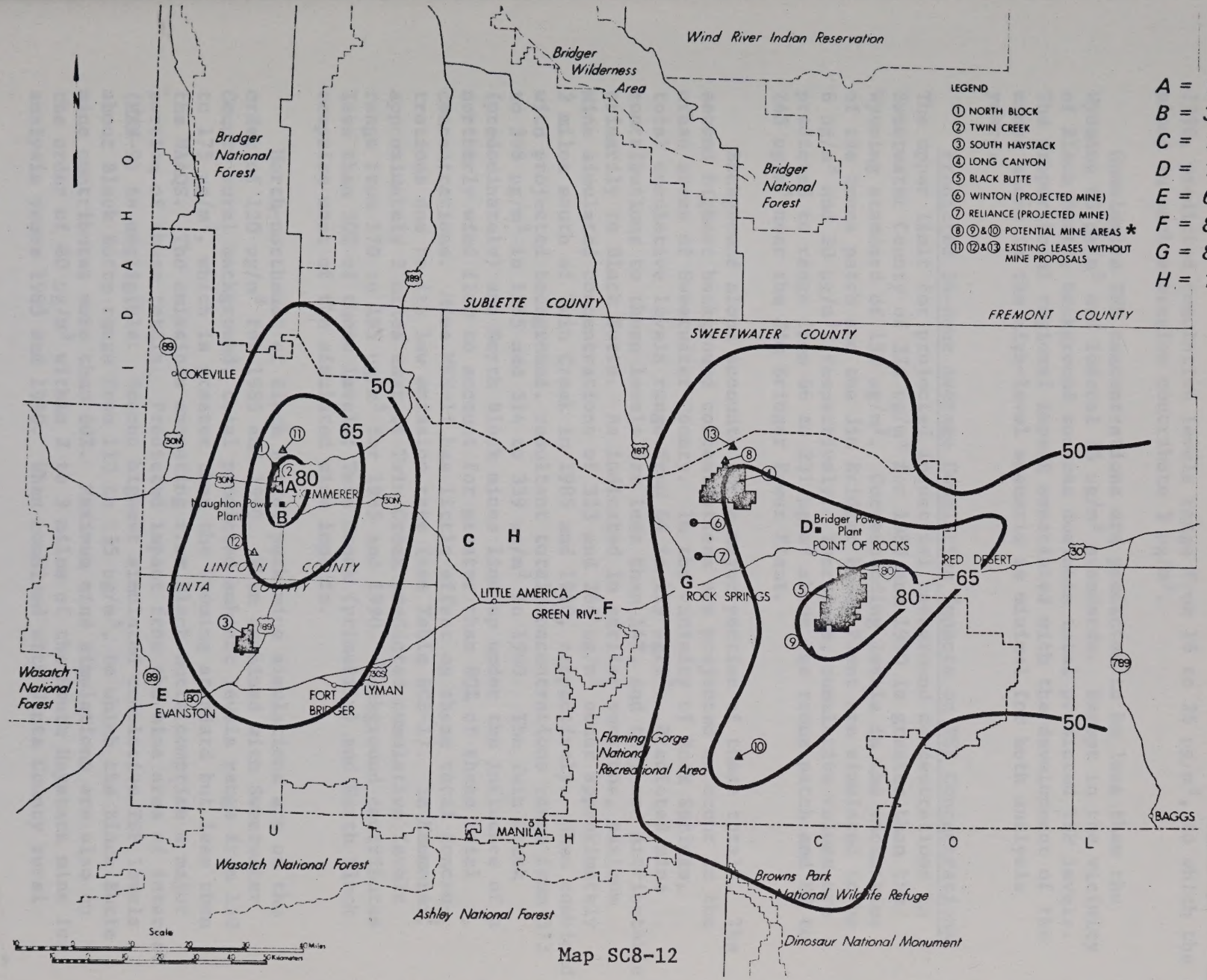

High-Level Scenario: Cumulative 1990 Predicted 24-Hour Average TSP Concentrations ($\mu g/m^3$)

*Equivalent to "mine areas of interest."

1990, predicted cumulative levels range from 16 to 26 $\mu g/m^3$, to which the mines in each subregion contribute 3 $\mu g/m^3$.

Cumulative TSP concentrations are predicted to be less than the Wyoming 60 $\mu g/m^3$ and federal 75 $\mu g/m^3$ standards. Except in the vicinity of Black Butte, background sources dominate total predicted TSP levels. The proportional regional impact associated with the development of the mines alone in the high-level scenario is minimal for both analysis years.

Predicted 24-Hour Average Cumulative Impacts on TSP Concentrations. The upper limit for projected industrial background concentrations in Sweetwater County of 225 $\mu g/m^3$ for 1985 and 1990 is greater than the Wyoming standard of 150 $\mu g/m^3$. Corresponding levels in the vicinities of the trona patch and the Jim Bridger Power Plant are simulated to be 6 $\mu g/m^3$ and 20 $\mu g/m^3$, respectively. Therefore, cumulative values are predicted to range from 66 to 231 $\mu g/m^3$ about the trona patch and 80 to 245 $\mu g/m^3$ near the Jim Bridger Power Plant.

Background alone accounts for a major portion of these totals. The second highest background concentrations are projected to occur in the urban areas of Sweetwater County. In the vicinity of Rock Springs, total cumulative levels range from 64 to 119 $\mu g/m^3$. Predicted mine contributions to these levels are less than 14%, and they are attributable primarily to Black Butte. As indicated in earlier sections, maximum mine simulated concentrations of 323 and 264 $\mu g/m^3$ occur approximately 2 miles south of Twin Creek in 1985 and 1990, respectively. When combined with projected background, resultant total concentrations range from 373 to 398 $\mu g/m^3$ in 1985 and 314 to 339 $\mu g/m^3$ in 1990. The Twin Creek (predominately) and North Block mines line up under the influence of a northerly wind flow to account for greater than 80% of these total concentrations. Mine MRN-11 has little effect on these total concentrations due to its low emission rate (see Table SC8-1). In Kemmerer, approximately 2 miles east of Twin Creek predicted cumulative levels range from 170 to 195 $\mu g/m^3$ for 1985 and 1990. Background contributes less than 30% of these levels; Twin Creek (primarily) and North Block comprise most of the simulated mine impacts.

North-northeast of Black Butte, peak mine simulations are on the order of 120 $\mu g/m^3$ for 1985 and 1990. When combined with Sweetwater County rural background, total predicted ambient levels range from 150 to 175 $\mu g/m^3$, which is greater than the Wyoming standard but less than the NAAQS. The emissions emanating from Black Butte comprise a major portion of these totals. Predicted impact from the mine area of interest (MRN-9) is negligible. Second highest simulated cumulative TSP levels about Black Butte range from 110 to 135 $\mu g/m^3$, to which the Black Butte mine contributes more than 60%. Maximum mine simulations are also on the order of 80 $\mu g/m^3$ within 2 to 3 miles of the South Haystack mine for analysis years 1985 and 1990. When combined with Uinta County rural

background, ranges of 110 to 130 $\mu g/m^3$ characterize cumulative TSP levels. The South Haystack mine alone comprises more than 60% of these total concentrations. Cumulative levels about the Long Canyon mine range from 50 to 75 $\mu g/m^3$. Long Canyon and surrounding mines contribute approximately 10 to 20 $\mu g/m^3$ to such levels, the remainder is attributable to rural background in Sweetwater County.

In the vicinity of potential mine area MRN-10, peak predicted cumulative levels about the mine range from 55 to 80 $\mu g/m^3$ in 1985 and 1990. Mine MRN-10 contributes 25 $\mu g/m^3$ to these levels, the rest is attributable to background. As indicated in Table SC8-1, this mine is associated with an estimated annual emission rate that is at least 50% higher than any other mine area of interest or existing lease mine. Consequently, predicted impact from this mine is greater than the additional mines comprising the high level scenario. However, compared to the emission rates of the five proposed action mines, MRN-10 is a relatively minor source of fugitive dust. In fact, on a regional scale, predicted impacts associated with mines MRN-8 through MRN-13, which define the high-level scenario, are insignificant.

Elsewhere in the ES region, cumulative TSP levels are predicted to be lower than the 150 $\mu g/m^3$ Wyoming standard, and they become quite low as distance from the mine sites increases. Regionally, background levels dominate predicted cumulative levels with increased distance from the mine sites.

Natural catastrophes, such as coal fires and drought, are other potential sources of particulate emissions. Associated impacts are difficult to assess quantitatively, although maximum air quality degradation would occur on a very local scale. A qualitative discussion relative to such catastrophes is presented in Chapter 4.

Cumulative impacts on gaseous pollutants (CO, HC, NO_2, and SO_2) are similar to those associated with the proposed actions and, therefore, insignificant when compared to the standards. Refer to Chapter 4 for a more detailed discussion.

Indirect Air Quality Impacts

Additional air pollutant emissions would result from indirect sources related to the high-level coal development scenario. Consequently, baseline SP concentrations are also expected to increase and have been projected to future analysis years; these projected levels are equivalent to the ranges presented in Table SC4-10. The SP concentrations simulated for the high-level mines have been combined with projected baseline levels to determine the cumulative impacts discussed in the previous section.

Quantitative indirect source impacts to variations in baseline SO_2 and NO_x concentrations are unknown (see Chapter 2 Regional Technical Report). However, the contributions from the mines are expected to be negligible.

Probable Cumulative Regional Impacts

A brief enumeration on the transport of aerosols and their possible effects on climate is presented in the Chapter 2 Regional Technical Report. However, the available data do not provide a firm basis for conclusive statements about what role high-level mining activities would play in altering the ES region's existing climate over the next fifteen years.

Visibility

The methodology used to evaluate the impact of the high-level scenario on visibility is identical to the technique described in Chapter 4. Regional background visibilities are assumed to be 40 miles for each year based on current visibility observations and evaluation of projected regional background SP values.

In 1985, for the high-level scenario considered, worst-case 24-hour SP concentrations attain values as high as 323 $\mu g/m^3$ in the vicinity of the proposed North Block and Twin Creek mines. This corresponds to a visibility of 20.1 miles, assuming a background of 40 miles. Most of the region, however, is outside the 20 $\mu g/m^3$ isopleth, which corresponds to a visibility of 37.7 miles, a reduction of 2.3 miles from the background.

Concentrations in the Bridger Wilderness Area (Class I) are between 1 and 2 $\mu g/m^3$. This level of SP yields a visibility of 39.8 miles for a reduction of less than 0.7% from the background. In the vicinity of Flaming Gorge National Recreational Area (Class II), SP values are between 6 and 7 $\mu g/m^3$, giving visibilities of 39.2 miles (visibility degradation 2.1%). At Fossil Butte, concentrations are approximately 25 $\mu g/m^3$. The computed visibility and visibility degradation are 37.2 miles and 7.1%, respectively.

For 1990, worst-case 24-hour SP concentrations attain values as high as 264 $\mu g/m^3$ in the vicinity of the proposed North Block and Twin Creek mines. This corresponds to a visibility of 22.1 miles, assuming a background of 40 miles. Most of the region, however, is outside the 20 $\mu g/m^3$ isopleth, which corresponds to a visibility of 37.7 miles, a reduction of 2.3 miles from the background.

Concentrations in the Bridger Wilderness Area (Class I) are about 1 $\mu g/m^3$. This level of SP yields a visibility of 39.9 miles, for a reduction of less than 0.3% from the background. In the vicinity of Flaming Gorge National Recreational Area (Class II), SP values are between 3 and 4 $\mu g/m^3$, giving a visibility of 39.5 miles (visibility degradation 1.3%). At Fossil Butte, concentrations are approximately 22 $\mu g/m^3$. The computed visibility and visibility degradation are 37.5 miles and 6.3%, respectively.

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